How to Service Electronic Organs

AUGUST 1959

Radio-Electronics

HUGO GERNSBACK, Editor

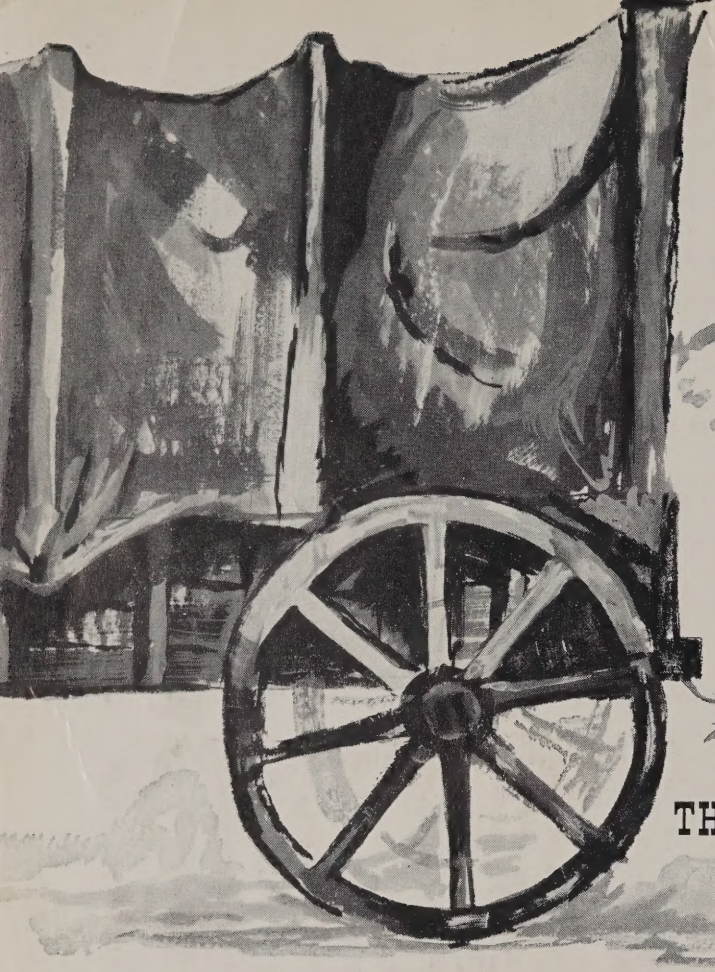
35c

Should I Take a Home Study Course?

Add a Control For Pix Quality

Multiple-Socket Testers Speed Tube Checking

How to Finish Your Hi-Fi Cabinet



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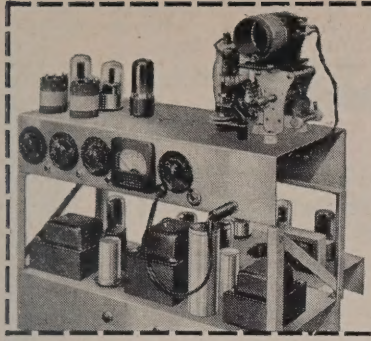
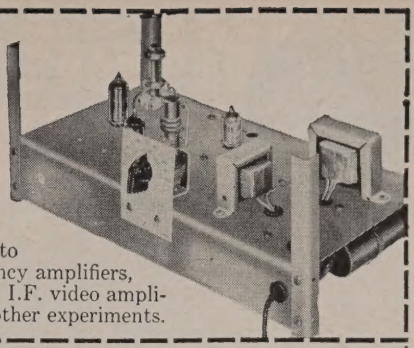


YOU BUILD Broadcasting Transmitter

As part of N.R.I. Communications Course you build this low power Transmitter; use it to learn methods required of commercial broadcasting operators, train for FCC license.

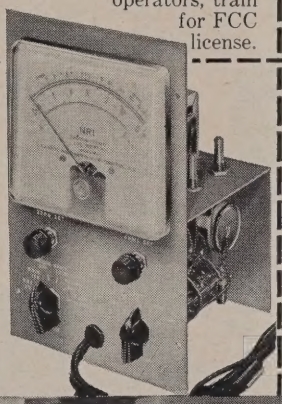
YOU BUILD Signal Generator



N.R.I. sends kits of parts to build this Signal Generator. You get practical experience, conduct tests to compensate Radio frequency amplifiers, practice aligning a typical I.F. video amplifier in TV circuit, many other experiments.

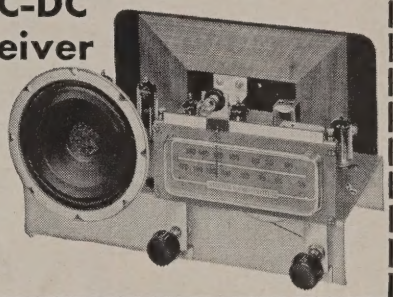
YOU BUILD Vacuum Tube Voltmeter

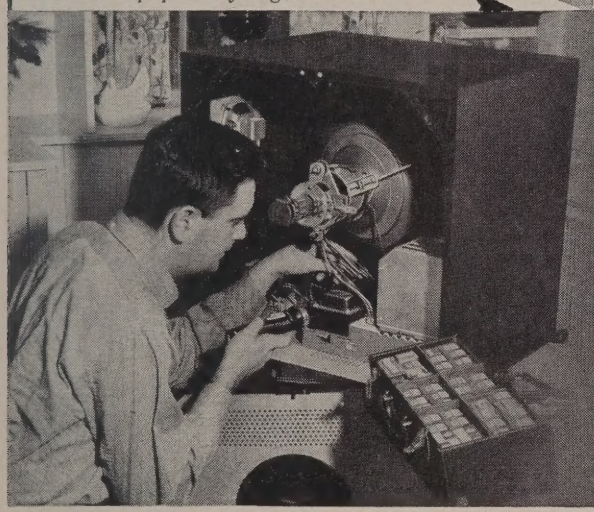
Use it to get practical experience, earn extra cash fixing neighbors' sets in spare time, gain knowledge to help you work in Radio, Television, Color TV. With N.R.I. training you work on circuits common to both Radio and TV. Equipment you build "brings to life" things you learn in N.R.I.'s easy-to-understand lessons. 64 page Catalog FREE, shows all equipment you get.



YOU BUILD AC-DC Superhet Receiver

N.R.I. servicing training supplies all parts, everything is yours to keep. Nothing takes the place of practical experience. You get actual servicing experience by practicing with this modern receiver; you learn-by-doing.





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by Practicing at Home

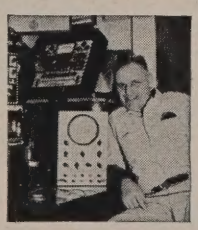
WHAT GRADUATES DO AND SAY

Chief Engineer

"I am Chief Engineer of Station KGCU in Mandan, N. D. I also have my own spare time business servicing high frequency two-way communications systems." R. BARNETT, Bismarck, North Dakota.

Paid for Instruments

"I am doing very well in spare time TV and Radio. Sometimes have three TV jobs waiting and also fix car Radios for garages. I paid for instruments out of earnings." G. F. SEAMAN, New York, N. Y.



Has Own TV Business

"We have an appliance store with our Radio and TV servicing, and get TV repairs. During my Army service, NRI training helped get me a top rated job." W. M. WEIDNER, Fairfax, South Dakota.

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ON THE COVER

(story on page 46)

First transistorized TV to reach the market, the Philco projection receiver has a picture optically equivalent to a 12-inch tube, is viewable outdoors in bright daylight. The projection tube is seen between set and case.

Color original by Philco Corp.

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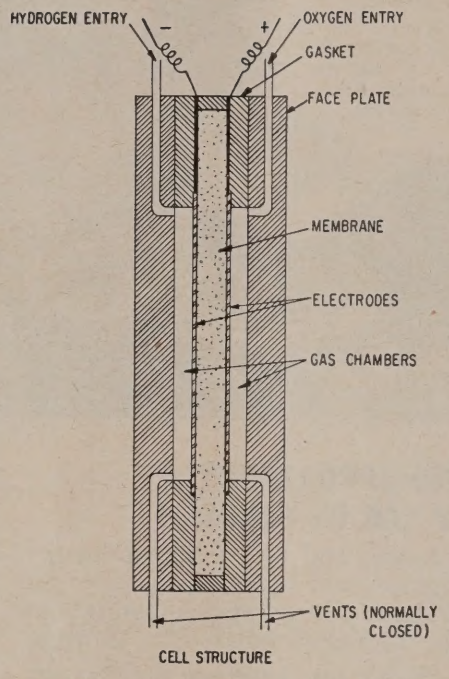
NEWS BRIEFS

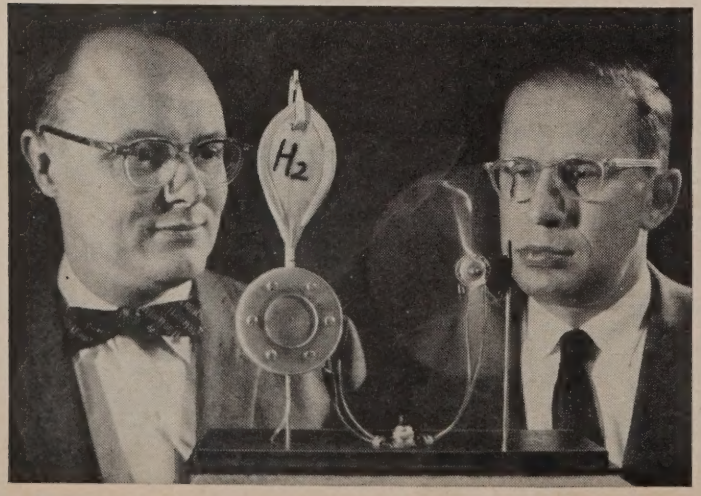
TAPE CARTRIDGE PLAYERS for 3¾ inch-per-second 4-track tape are now on the market. RCA has shipped production units of its first model, priced at $300. Bell Sound, selling standard tape decks and recorders through audio components dealers for several years, followed suit with an announcement that it will offer six models to play the slow-speed 4-track cartridges. These models start with a simple tape deck minus electronics, for use with high-fidelity amplifiers, range up through a unit including complete electronics.

Meanwhile, the Magnetic Recording Industry Association (MRIA) said that its recent announcement of industry agreement to push sales of 4-track, 7½-inch, *reel-to-reel* stereo tape would not be affected by RCA's finally marketing the long-awaited magazine players. MRIA officials echoed Bell Sound's position that 4-track tapes at 7½ inches will provide high-fidelity stereo whereas the slower-speed magazine tapes will provide tape for the mass market.

ELECTRICITY DIRECT FROM GAS is now a reality in a new "fuel cell" developed by G-E scientists which creates low-voltage dc directly from combining hydrogen and oxygen. The fuel cell, according to Drs. W. Thomas Grubb and Leonard W. Niedrach of the G-E research laboratory, consists of a round plastic disc about ½ inch thick and 3 inches in diameter. Its hollow interior is divided into two chambers by a special plastic membrane, which has an electrode in contact with each of its sides (see diagram). Hydrogen is fed into one chamber, and oxygen into the other (or oxygen in the air can be used). At one electrode, the hydrogen molecules break up into electrons and positively charged hydrogen. The electrons travel through an external load circuit to the other electrode, thus creating an electric current. The positively charged hydrogen moves through the membrane to the other electrode, where it combines with oxygen and the electrons from the external circuit to form water. The fuel cell generates electricity by a chemical reaction. In the present version, hydrogen and oxygen produce an electric current, with water as a byproduct. Current densities as high as 30 ma to the square centimeter have been achieved with an open-circuit voltage of approximately 1 volt per cell. Thermal efficiency of 60% has been reached.



CELL STRUCTURE



G-E's Leonard Neidrach (left) and Thomas Grubb with their "fuel cell."

COLOR TV GAINS on all fronts this fall predicted in many quarters. RCA carried the ball almost alone for the past 2 years; now Admiral has announced a full color receiver line. All networks are planning increased color-casting. Leader in this effort appears to be NBC, with 169 affiliated color-equipped stations set. NBC's fall color schedule will be almost one-third heavier than last year's, with color every night, 2 hours on Saturday daytime and increased sports coverage. CBS now has

(*Continued on page* 10)

Calendar of Events

Hoosier Electronic Conference, Aug. 9–12, French Lick Sheraton Resort Hotel, French Lick, Ind.

National Ultrasonics Symposium, Aug. 17, San Francisco, Calif.

Western Electronic Show and Convention, (WESCON), Aug. 18–21, Cow Palace, San Francisco, Calif.

German Radio TV & Phono Exposition, Aug. 14–23, Frankfurt am Main, Germany.

National Alliance of Television & Electronic Service Assocs. (NATESA) Convention, Aug 20–23, Congress Hotel, Chicago.

British Radio Show, Aug. 26–Sept. 5, Earls Court, London, England.

National Exhibition of Radio, Television and Records, Sept. 10–21, Exhibition Park, Porte de Versailles, Paris, France.

High-Fidelity Music Show, Sept. 11–13, Hotel Pfister, Milwaukee, Wis.

Heart of America Rep Conference, Sept. 12–13, Excelsior Springs, Mo.

Upper Midwest Electronic Exposition, Sept. 15–17, Minneapolis Municipal Auditorium, Minneapolis, Minn.

High-Fidelity Show, Sept. 18–20, Palmer House, Chicago, Ill.

Instrument-Automation Conference & Exhibit, Sept. 21–25, International Amphitheatre, Chicago, Ill.

EIA Fall Conference, Sept. 22–24, Traymore Hotel, Atlantic City, N. J.

Conference on Non-Linear Magnetics and Magnetic Amplifiers, Sept. 23–25, Shoreham Hotel, Washington, D. C.

High-Fidelity Music Show, Sept. 25–27, Hotel Sheraton, Rochester, N. Y.

National Symposium on Telemetering, Sept. 28–30, Civic Auditorium & Whitcomb Hotel, San Francisco, Calif.

Industrial Electronics Symposium, Sept. 30–Oct. 1, Mellon Institute, Pittsburgh, Pa.

Men 17-55

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Are YOU One of the men who could prepare for a job that PAYS REAL MONEY in TELEVISION RADIO Electronics

ONLY DeVRY OFFERS ALL THESE FEATURES!

Only DeVry Tech provides Training Movies to make the basic principles of Electronics crystal clear! DeVry's explanations and illustrations are a pleasure to follow. Over 300 practical experiments with actual Electronic parts are included to give you on-the-job type know-how. You even build your own test equipment.

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You meet them almost every day . . . the men who want to advance out of humdrum, low-pay, or no-future jobs. Some are men who had to quit school too soon; men just out of school with no idea of what to do; or men looking for help in planning a better future. Yet, many of them could—can, if they're 17-55—train at home, in their spare time, for an exciting career with real money and an inspiring future in the field of Electronics. And the tragedy of it is: they don't know it! They think they need an advanced education, or some special experience, or a lot of money, to start—but what they need most is the will to win. Maybe you're a man like that. Well, here's great news! It's not too late! Electronics offers men like you, when trained, dozens of different job opportunities—from guided missile control to running your own radio-television service shop. Get the full story of the jobs you may prepare for . . . NOW . . . BEFORE the years and responsibilities close in on you. Send coupon today—no obligation.

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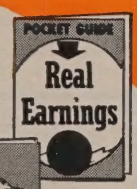

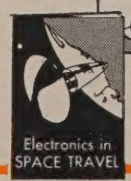

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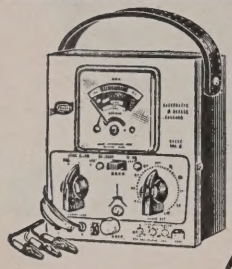
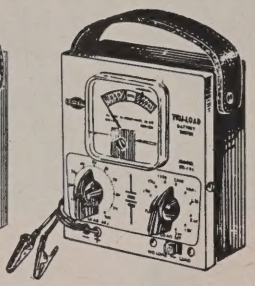


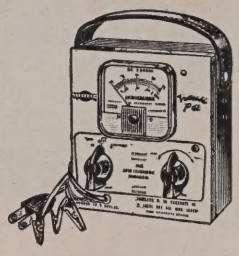
TRC4 TRANSISTOR CHECKER—Tests transistors for opens, shorts, leakage and current gain. Includes gain test on power transistors. Checks all crystal diodes for forward to reverse current ratio. Checks seleniums for forward and reverse currents. Controls are accurately set for each transistor by referring to set up chart on rear of unit. Test leads or socket for fast hook-up. Cannot become obsolete.

Net Each.....$17.95



BT-101 TRU-LOAD BATTERY TESTER—Tests all batteries under manufacturers recommended loads—even small mercury cells, without damage. Ideal for transistor work. Load setting is determined from current capability instead of battery voltage. So simple to operate that a counter girl can learn to use it in a few minutes, yet accurate enough for labs.

Net Each.....$15.95



PS-103 TRANSI-PAC TRANSISTOR POWER SUPPLY—A low cost DC power supply for all portable transistor radios. 0-24 volts adjustable with a 1½ volt tap for Philco and Sylvania radios. Meter on unit reads voltage applied. Flick of switch and meter shows current drain. Current scale reads to 100 Mills. Operates push-pull radios with tap above 1.5 volts by using center lead as phantom ground.

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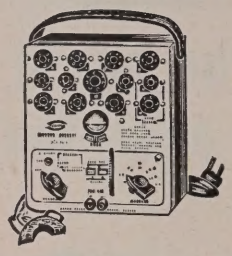
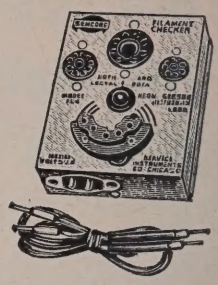
SENCORE Tube Checkers make quick-accurate checks



LC3 LEAKAGE CHECKER—Tests nearly 200 different tube types including UHF and latest types; Checks CRT without removing tube from chassis. Roll-Chart design for quick checking; prevents obsolescence. Two spare pre-heating sockets cut down test time. Dynamic filament checks include heater to cathode leakage and shorts. Leakage sensitivity is 100 megs and 50,000 ohms; can be increased by changing the value of one resistor only. Capacitors can be easily tested for leakage to 100 megs, opens, shorts and charge with voltage applied. Compact unit 7"x6"x3½" comes in black hammertone case with aluminum panel. Weight 3 lbs.

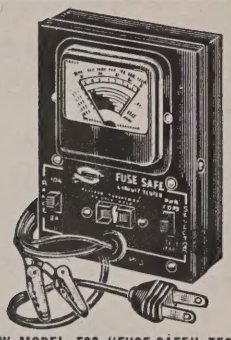
Net Each.....$28.95



FC4 FILAMENT CHECKER—Here is a new filament checker that automatically tests ALL tubes, including loctals and picture tubes; and also acts as a continuity and voltage tester. Continuity and voltage checks are made by simply plugging test leads into pins 1 and 12 of the picture tube socket—no switches. A neon indicator acts as a voltage indicator as well as GOOD-BAD tube tester.

Net Each.....$2.75
With Leads.....$2.95

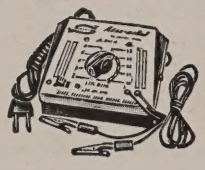
Eliminates Costly Call-Backs



NEW MODEL FS3 "FUSE-SAFE" TESTER—Prevents expensive call-backs on fuses and fuse resistors. Tests fuse, fuse resistor or circuit breaker circuits. Has individual scale for each value fuse resistor; reads red or green. Measures wattages up to 1100 watts at 115 volts. Two current ranges, 0-2 amps. and 0-10 amps. Test leads clip in place of fuse or fuse resistor. Tests both AC and DC. Safety 5-ohm, 10-watt resistor prevents circuit damage; simulates operating conditions.

Sencore Model FS3 Circuit Tester
Net Each.....$8.95

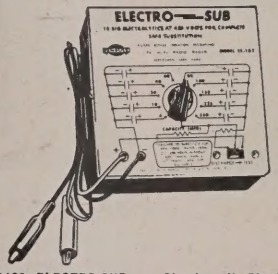
For AGC and Alignment Work



MODEL BE3 ALIGN-O-PAK — Fully isolated DC supply for TV alignment—AGC troubleshooting and other DC checking requirements. Provides all DC voltages recommended by TV manufacturers. Provides 0 to 18 volts, positive or negative, with less than 0.1% ripple. For alignment, merely plug in 115-volt AC and set knob at required voltage; for AGC trouble shooting, connect to AGC buss and vary voltage from 0 to 18 volts neg. If picture stabilizes, AGC is defective. Black hammertone case with aluminum panel. Complete with test leads. Shipping Weight, 2 lbs.

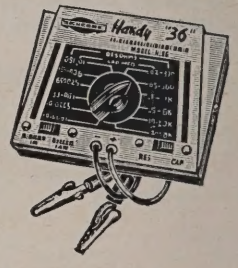
Sencore Model BE3 Align-O-Pak
Net Each.....$7.85

Capacitors and Resistors at your fingertips for *Easy-Safe-Substitution*



ES102 ELECTRO-SUB — Checks all Electrolytic Capacitators in seconds, merely select the electrolytic and substitute it. 10 big electrolytics from 4 to 350 mfd to safely substitute in any circuit from 2 to 450 volts. Automatic capacitor discharge within seconds. Unique surge protector circuit prevents accidental healing of capacitor being "bridged," completely safe. Compact unit can be carried anywhere, measures 4¾" h. x 4¾" w. x 2¼" d.

Net Each.....$15.95



NEW MODEL H36 R-C SUBSTITUTOR—Provides 36 of the most often needed components for direct substitution: 12 one-watt 10% resistors from 10 to 5600 ohms; 12 half-watt 10% resistors from 10K ohms to 5.6 megs.; 10 capacitors from 100 uuf to 0.5 uf, 600 volts; one 10 uf and one 40 uf 450 volt electrolytic. Three-pole, 12-position switch selects each component individually.

Sencore Model H36 R-C Substitution Unit
Net Each.....$12.75
Leatherette Carrying Case for H36—Net Ea. **$2.95**

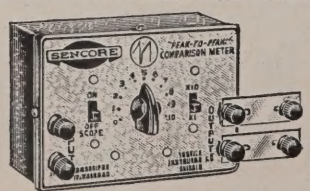
Quick check for Vibrators

MODEL VB2 "VIBRA-DAPTOR"—Permits checking vibrators in any tube checker; provisions for 3- or 4-prong vibrators. Plugs into tube tester; set for 6AX4 (or 6SN7) for 6-volt, 12AX4 (or 12SN7) for 12-volt vibrators. Two lamps in top of adaptor indicate good or bad. Rugged steel construction. Unbreakable #51 lamps are used. Complete instructions screened on front.

Sencore Model VB2 "Vibra-Daptor"
Net Each.....$2.75

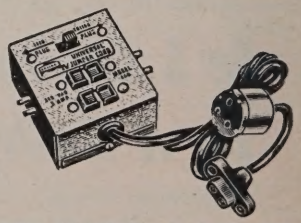
MODEL LB2 UP-DOWN VOLTAGE BOOSTER—For TV set or appliance up to 300 watts. No need to contend with inadequate picture width, insufficient height, low picture brightness, poor sync and oscillator drift, low sensitivity in fringe areas and/or excessive tube failure, due to lower than normal or higher than normal line voltages. Increase or decrease line voltage 10 volts with the flick of a switch.

Sencore Model LB2 Up-Down Voltage Booster
Net Each.....$5.97
Sencore Model LB2N Up-Down Voltage Booster—Same as above except with neon warning light that glows at 126 volts.
Net $7.17



MODEL PP2 PEAK-TO-PEAK METER—Completely assembled peak-to-peak meter for quickly servicing gated AGC and sync separator circuits. Occupies minimum space on the bench—only 4" x 6" x 3". Installed in seconds. A real time saver when servicing any TV set or electronic circuit. Essential for color with up to six gated circuits. Permanently connected to scope—straight through when turned off. Uses wire-wound potentiometer for accuracy. Calibrated against Dumont Calibrator and Textronix scope.

Sencore Model PP2 Peak-to-Peak Meter
Net Each.....$8.75



MODEL JC2 UNIVERSAL TV JUMPER CORD—Universal jumper cord that can be utilized with any TV set. Extends power from back of TV set—no moving furniture to get to the wall plug. Two handy power outlets for soldering iron and test equipment. Will fit many speakers, focus coils, etc. Two plugs accommodate all TV rearboard sockets and two sockets to fit the interior connections. Requires 115 v. AC, 3 amps.

Sencore Model JC2 Jumper Cord
Net Each.....$1.95

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ownership of a PHOTOFACT SERVICE DATA LIBRARY SPELLS SUCCESS FOR SERVICE TECHNICIANS

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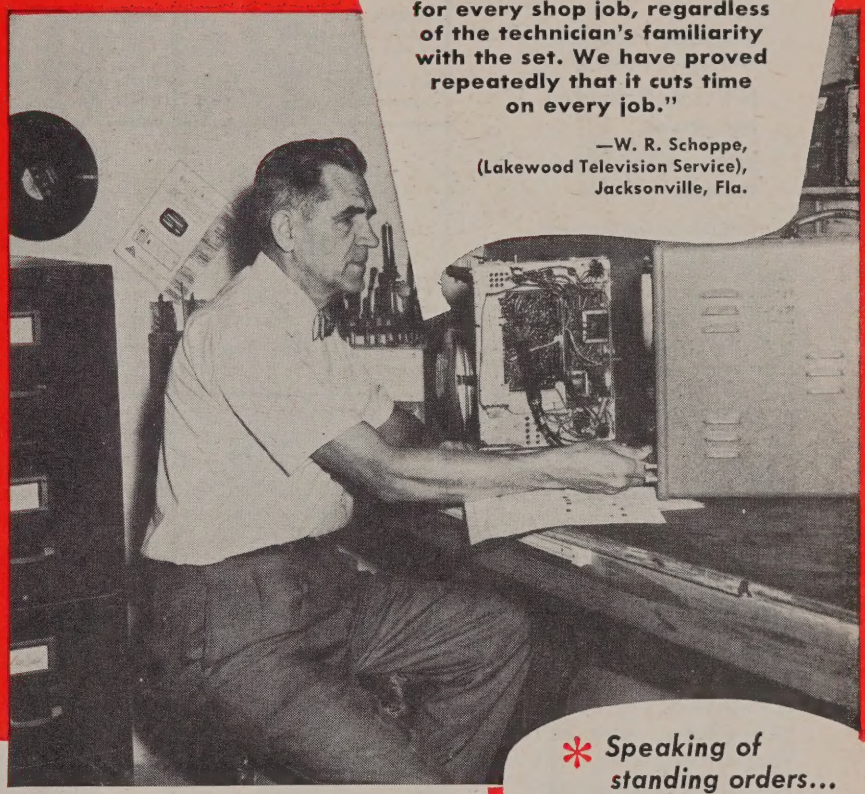
"PHOTOFACTS are a tremendous aid to a service technician in that they save hours of unnecessary work."

—E. C. Cenardo,
("Tune-In" TV-Radio Sales & Service),
Hollywood, Calif.

"It is impossible to do business without PHOTOFACT. It is a standing order* in our shop to pull PHOTOFACT from the file for every shop job, regardless of the technician's familiarity with the set. We have proved repeatedly that it cuts time on every job."

—W. R. Schoppe,
(Lakewood Television Service),
Jacksonville, Fla.



HERE'S MORE PROOF...FROM COAST-TO-COAST

"PHOTOFACTS mean so much to my business that I would not think of operating for any length of time without them."
—James G. Haynes
Leitchfield, Ky.

"The PHOTOFACTS that I have purchased on the Easy-Buy plan have been paying for themselves each month."
—Donald Johnson
Hector, Minn.

"PHOTOFACT means faster service to my customers, and more sets through my shop, which means more profit to me."
—Frank J. Schumacher
Hillsboro, Ore.

"I would be lost without SAMS PHOTOFACT. PHOTOFACT has become a part of servicing."
—Joseph S. Musil
Stamford, Texas

"PHOTOFACT means quicker and more efficient service to the customer."
—Wesley F. Scott
Logansport, Ind.

"Would not be without my PHOTOFACTS. Their return in time saved on servicing, pays for their cost many times over."
—E. R. Hayes
Clemson, S. Car.

(These are just a few of the hundreds of "Success with PHOTOFACT" letters in our files)

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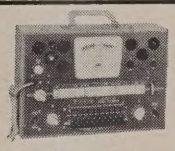
MODEL B-10
Battery Eliminator Kit
• less than 0.3% ripple output
• no external filters required
Kit Net Price: $41.95
Factory Wired: $49.50

MODEL S-55
Wideband 5" Oscilloscope
• response DC to 5 Mc
• push-pull V and H amplifiers
Kit Net Price: $87.50
Factory Wired: $139.50

MODEL C-20
Res-Cap-Ratio Bridge Kit
• 10 mmfd to 2000 mfd
• ½ ohm to 200 megs
Kit Net Price: $20.95
Factory Wired: $31.50



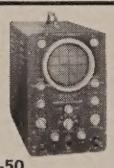
MODEL T-60
Tube Checker Kit
• full free-point lever selector system
• built-in roll chart
Kit Net Price: $38.75
Factory Wired: $54.50

MODEL G-30
RF Signal Generator Kit
• 160 Kc to 240 Mc in 8 bands
• 120 Mc fundamental output
Kit Net Price: $28.50
Factory Wired: $39.95

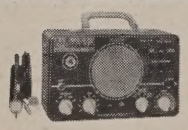
MODEL T-65
Transistor and Crystal Diode Tester Kit
• tests Icbo, gain, leakage, etc.
• tests both p-n-p and n-p-n types
Kit Net Price: $39.95
Factory Wired: $59.50

MODEL M-40
High Sensitivity V-O-M Kit
• 20,000 ohms/volt DC
• 10,000 ohms/volt AC
Kit Net Price: $31.50
Factory Wired: $37.50

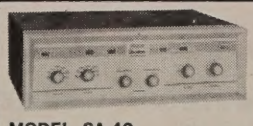
MODEL V-70
Vacuum Tube Voltmeter Kit
• wide-range
• peak-to-peak
Kit Net Price: $31.50
Factory Wired: $47.50



MODEL S-50
5" Cathode Ray Oscilloscope Kit
• push-pull vertical and horizontal amplifiers
Kit Net Price: $49.50
Factory Wired: $84.50



MODEL Z-80
RF-AF Signal Tracer Kit
• high gain RF and AF amplifier
• visual and audible indicator
Kit Net Price: $29.50
Factory Wired: $42.50



MODEL SA-40
40-Watt Stereo Preamp-Amplifier
• silicon diode, low impedance power supply
• 14 controls for optimum flexibility
Kit Net Price: ..... $ 79.95
Factory Wired: $129.95

COMING SOON!

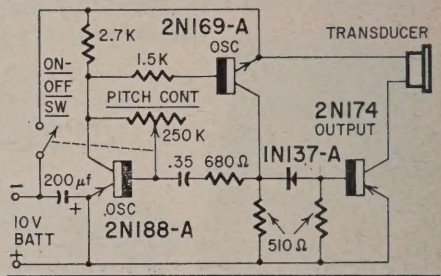
MODEL ST-45
AM/FM Stereo Tuner Kit
Matching companion for the SA-40

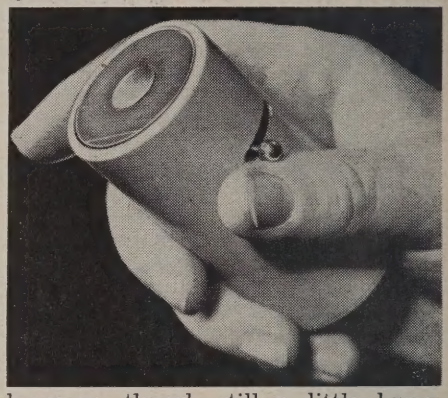
PACO

NEWS BRIEFS *(Continued from p. 6)*

155 stations with color equipment; ABC 138.

ARTIFICIAL VOICE for the 2,500 people in the US who lose their own through surgical removal of the larynx each year is a small unit (1¾ x 3¼ inches) with variable pitch and self-contained power supply. Speech quality is far better than that of previous artificial





larynxes, though still a little buzzy. The unit is pressed against one's throat and the pitch is varied by a finger pressure. Volume is the same as a normal conversational voice.

Transistors in a relaxation oscillator generate large pulses sent to a power transistor which drives a transducer similar to an ordinary telephone receiver. Pitch is varied between 100 and 200 cycles by a rheostat (range is set for 200–400 cycles for women users). Bell Laboratories scientists H. L. Barney and F. E. Haworth developed the device. (See also "Electronics Help the Mute to Speak," RADIO-ELECTRONICS, June, page 48.)

3 TV STATIONS have left the air since our July report:

KDPS-TV, Des Moines, Iowa.....11
KULR, Kalispell, Mont.....9
WNED-TV, Buffalo, N. Y.....17

KDPS-TV and KULR, both educational, are calling summer recesses, KDPS-TV until Sept. 14 and KULR for 120 days.

Our new figures are 554 US operating stations, including 467 vhf and 87 uhf. The temporary loss of KDPS-TV and KULR drops the noncommercial total to 41.

FCC MARKS QUARTER CENTURY of regulating communications through almost 2,500,000 radio authorizations. Of these 1,600,000 are commercial licenses such as marine, aviation, public safety, industrial and land transportation; 185,000 are amateurs.

(*Continued on page* 16)

Opportunities in Electronics

Do you know how you can convert your present electronics knowledge into a profitable and interesting career in any of the fields listed here?

Thousands of interesting well paid jobs in electronics must be filled. To fill such jobs, you need sound technical training. An FCC license is convincing proof of technical skill. Send for the three Cleveland Institute booklets offered here. They explain how you can prepare for an interesting and profitable career in electronics. Mail the coupon today—no obligation.

Find out how modern technical training and a Government License (FCC) can lead to profitable employment in any branch of electronics.

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- **Broadcasting**
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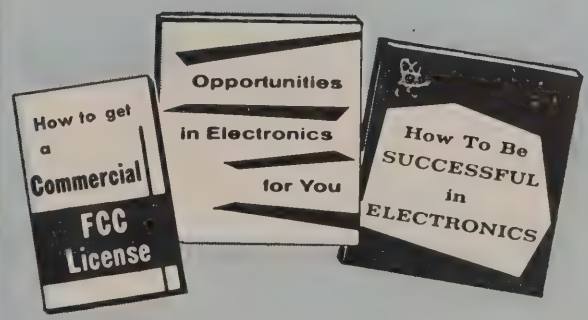
- **Computers**
- **Automation**
- **Industrial Electronics**
- **Home Electronics**



Send for these 3 FREE Booklets

Accredited by the National Home Study Council

Cleveland Institute of Radio Electronics

Desk RE-32B 4900 Euclid Ave. Cleveland 3, Ohio

Please send FREE Booklets prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

- ☐ Military
- ☐ Radio-TV Servicing
- ☐ Manufacturing
- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other.....

In what kind of work are you now engaged? .....

In what branch of Electronics are you interested? .....

Name..... Age.....

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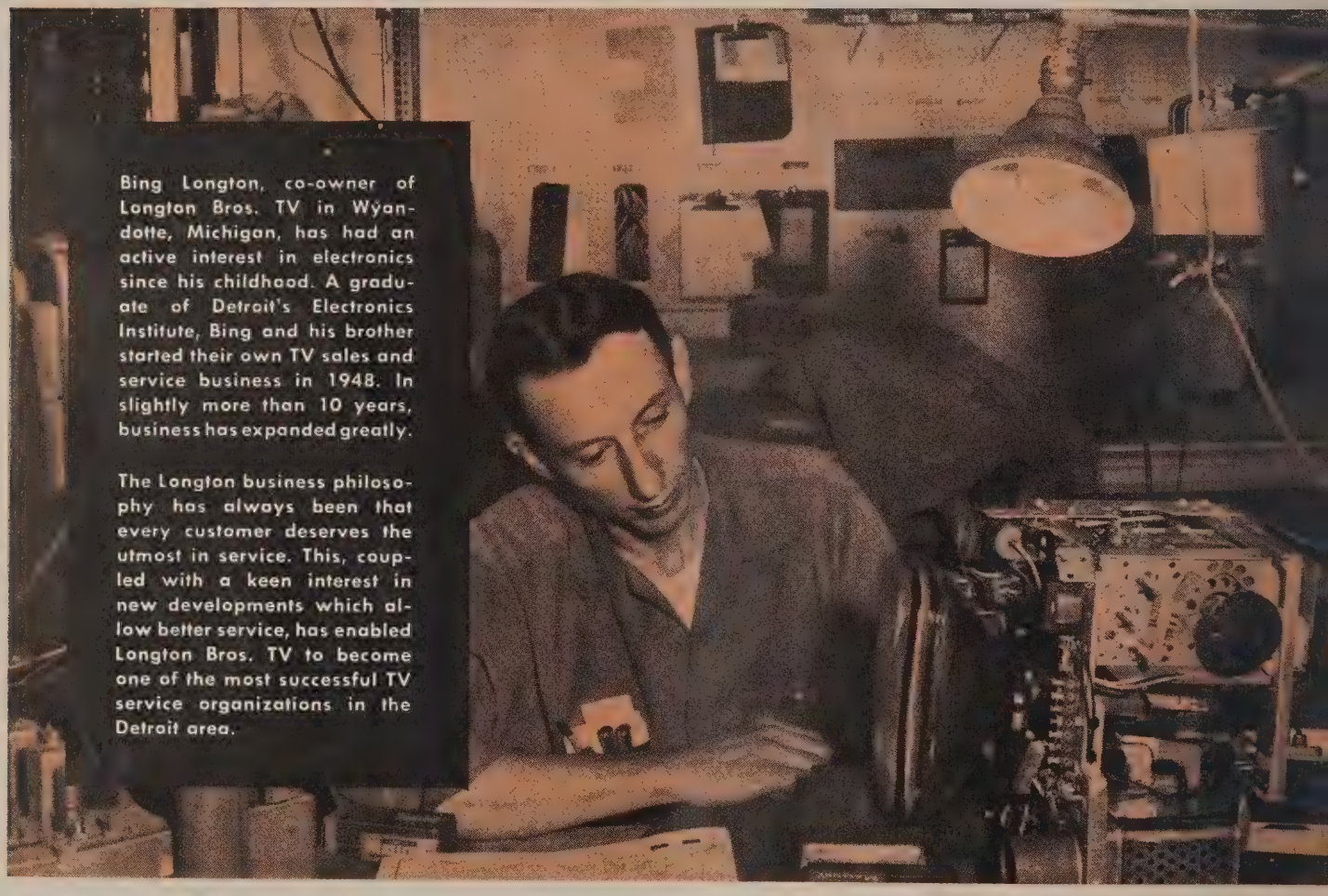
City..... Zone..... State .....

RE-32B

TV Technician Bing Longton says . . .

"We Can't Gamble With Customer



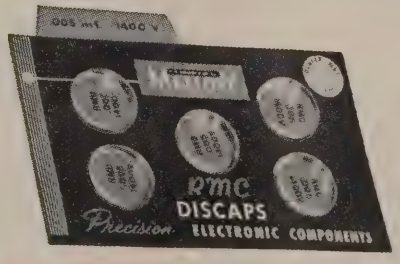
Bing Longton, co-owner of Longton Bros. TV in Wyandotte, Michigan, has had an active interest in electronics since his childhood. A graduate of Detroit's Electronics Institute, Bing and his brother started their own TV sales and service business in 1948. In slightly more than 10 years, business has expanded greatly.

The Longton business philosophy has always been that every customer deserves the utmost in service. This, coupled with a keen interest in new developments which allow better service, has enabled Longton Bros. TV to become one of the most successful TV service organizations in the Detroit area.

Put an end to call-backs with these quality Mallory products . . .

GEMS

5 rugged, moistureproof, Mallory "Gem" tubular capacitors in an easy-to-use dispenser that keeps your stock fresh and clean—easy to find—no more kinks in lead wires. They're your best bet for outstanding service in buffer, by-pass or coupling applications.



RMC DISCAPS®

Are a product of the world's largest producer of ceramic disc capacitors. Long the original equipment standard, Mallory RMC Discaps are now available for replacement. They come in a handy 3" x 5" file card package . . . easy to stock, simple to use.

®A registered trade mark of Radio Materials Company, a division of P. R. Mallory & Co. Inc.

FP ELECTROLYTICS

The Mallory FP—the original 85°C. capacitor—now has improved shock-resistant construction and leakproof seal. Its etched cathode construction—standard in all FP's—assures hum-free performance. High ripple current ratings fit the toughest filter circuits.

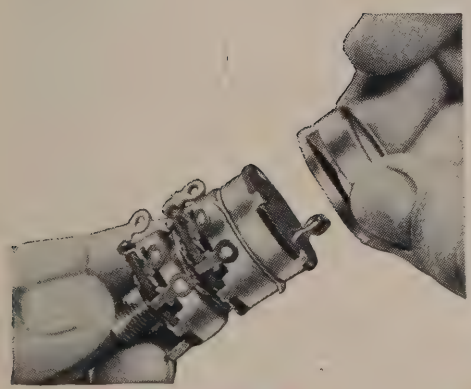
Satisfaction . . .We Use Mallory Components for Replacement"

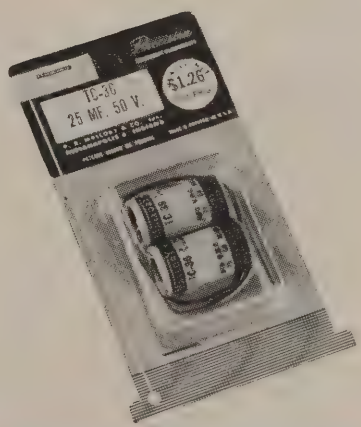
"Customers demand quality repair service, and at Longton TV the customer is *king*. We figure the best way to keep him happy . . . and protect our own profits, too . . . is to prevent complaints before they happen. So we give him the best in service and the best in replacement parts—that means MALLORY components. We've used them ever since we started in business, because we know we can always depend on MALLORY."

Whether you need capacitors, controls, resistors, silicon rectifiers or batteries, you get the highest quality components at sensible prices. The Mallory line is the widest in the industry, and Mallory "service-engineering" assures you fewer call-backs and more satisfied customers. See your Mallory distributor for a full selection of the parts you need.

Get TC capacitors at your distributor from this handy merchandise display.

P. R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA





STA-LOC* CONTROLS

New Sta-Loc design enables your distributor to custom build, in just 30 seconds, any of 38,000 combinations—eliminates waiting for out-of-stock controls. You can replace the line switch by itself, without unsoldering control connections.

GOLD LABEL* VIBRATORS

On critical auto radio servicing, use the Mallory Gold Label Vibrator. It gives longer, trouble-free service life. Mallory Gold Label Vibrators feature Mallory exclusive buttonless contact design.

Trade Mark

TC TUBULAR ELECTROLYTICS

Economically priced electrolytic filter capacitors with a reputation for doing an excellent job. They have been proved in performance and are backed by years of Mallory experience. Also special TCX type available for —55°C.

GET BEHIND THE SYLVANIA $2. Combination

America's biggest magazines deliver this business-building offer to over 100 million readers!

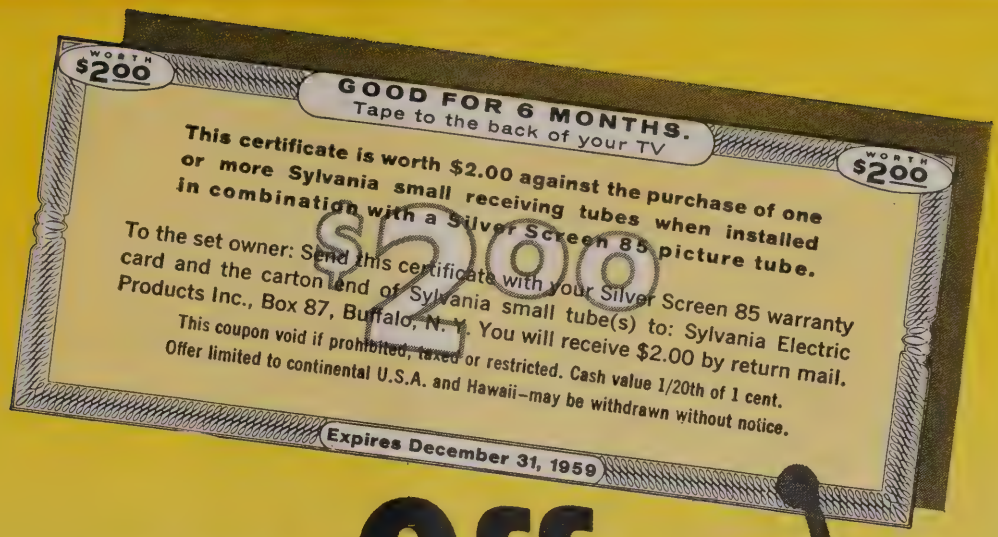
Look for this ad in these leading national magazines.

On June 20th Sylvania launches the dramatic combination coupon offer appearing in America's biggest weekly magazine, *TV Guide*, and America's biggest monthly magazine, *Reader's Digest*—plus *Sunday* and *Parade* newspaper supplement magazines.

Your Service shares the spotlight with top-quality Sylvania picture tubes and receiving tubes in a three-point program to make your customer's old TV set *better than when it was new.*

Month after month, more set owners will be saving the $2.00 coupon. Many will attach it to the back of their TV set so it's there for you to see.

You can identify yourself with this program by featuring Silver Screen 85 and Sylvania receiving tubes. Get behind the biggest, most practical, business-building offer ever made to the Service industry.


WORTH $2.00
GOOD FOR 6 MONTHS.
Tape to the back of your TV
WORTH $2.00
This certificate is worth $2.00 against the purchase of one or more Sylvania small receiving tubes when installed in combination with a Silver Screen 85 picture tube.
To the set owner: Send this certificate with your Silver Screen 85 warranty card and the carton end of Sylvania small tube(s) to: Sylvania Electric Products Inc., Box 87, Buffalo, N. Y. You will receive $2.00 by return mail.
This coupon void if prohibited, taxed or restricted. Cash value 1/20th of 1 cent.
Offer limited to continental U.S.A. and Hawaii—may be withdrawn without notice.
Expires December 31, 1959
$2.00

Coupon Offer

Sells your service and Sylvania receiving tubes in combination with every Silver Screen 85 you install

Here's an action-packed offer that can add an average of $3.00 to $6.00 in receiving tube business every time you install a Silver Screen 85 picture tube.

Sylvania urges your customers to have their receiving tubes checked to make sure they get full performance from their new Silver Screen 85. And, to emphasize the importance of replacing weak tubes, Sylvania offers to pay $2.00 toward the cost of Sylvania receiving tubes installed in combination with a Silver Screen 85.

Your customers mail the $2.00 certificate directly to Sylvania with the picture-tube warranty card and receiving-tube carton end. Nothing for you to sign or send.

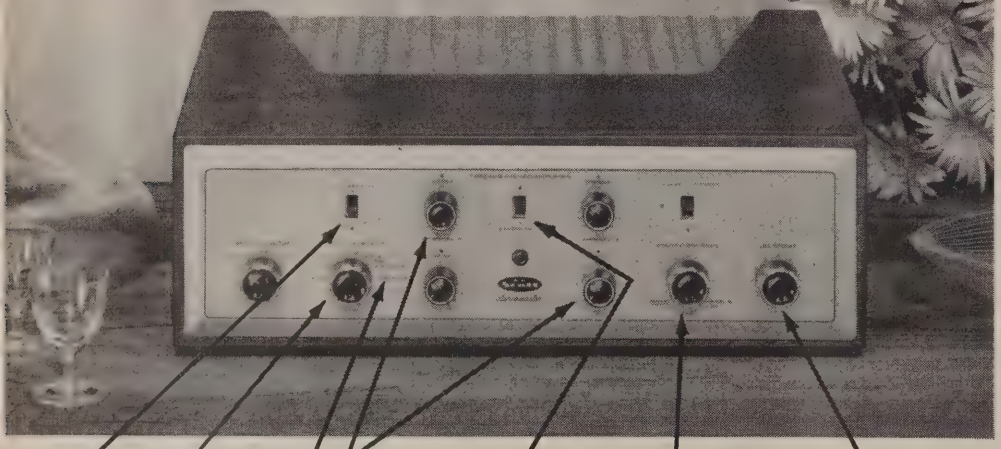
Stock up on Sylvania. Be prepared for greater-than-ever consumer demand for America's Number One picture tube and receiving tubes.

The Sylvania coupon taped to your customer's TV set means more receiving tube business and greater picture tube profits for you.

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

New H.H. Scott Stereo Amplifier has features never before offered at $139.95*

The new H.H. Scott 24 watt stereophonic amplifier, Model 222, puts top quality within the reach of all. This new amplifier has many features never before available for less than $200. It is backed by H.H. Scott's fine reputation. Check the features below and you'll see why you should build your new stereo system around the H.H. Scott Model 222.



Equalization switch lets you choose between RIAA compensation for monophonic and stereo records; NARTB, for tape heads.

Special switch positions for accurate balancing, for playing stereo, reverse stereo and for using monophonic records with your stereo pickup.

Separate Bass and Treble controls on each channel let you adjust for differences in room acoustics and different speaker systems.

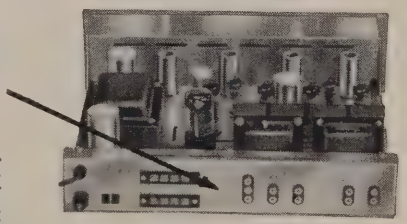
This position lets you play a monophonic source such as an FM tuner or a tape recorder through both power stages and speakers.

Effective scratch filter improves performance on older worn records and improves reception on noisy radio broadcasts.

Exclusive center-channel output lets you use your present amplifier for 3-channel stereo or for driving extension speakers. Separate stereo tape-recorder outputs.

Channel balance control adjusts for different speaker efficiencies and brings channel volumes into balance quickly and easily.

Master volume control adjusts volume of both channels simultaneously. Also functions as automatic loudness control whenever desired.



SPECIFICATIONS: Dual 12 watt channels; 0.3% IM distortion; 0.8% harmonic distortion; frequency response 20 to 30,000 cps; extremely low hum level (—80db); DC operated preamplifiers heaters; Inputs for stereo or monophonic recorders, tuners, phono cartridges and tape heads. Phono sensitivity 3 mv. Sub-sonic rumble filter prevents overload from noisy changers or turntables. Price $139.95*

H.H. SCOTT INC. Dept. RE-8, 111 Powdermill Road, Maynard, Mass. Export: Telesco International Corp., 36 W. 40th St., N.Y.C.

Insist on genuine H.H. Scott components

*West of Rockies $143.25. Accessory case extra.

h.h. Scott

SEND NOW FOR FREE HI-FI GUIDE AND CATALOG

Rush me complete details on your new Model 222 and your complete 1959 Hi Fi Guide & Catalog. Dept. RE-8

*Name*_____

*Address*_____

*City*_____ *State*_____

There are now 3,300 AM broadcast stations on the air, 600 FM and 435 vhf–TV, 75 uhf–TV. There are also over 200 legal translator stations working.

Two-thirds of the world's receiving sets (150,000,000 FM and AM, 50,000,000 TV), are in the United States.

TRENDS IN TV SETS are beginning to be seen in the new 1960 lines. In addition to the renewed push on color from Admiral and RCA, the 23-inch screen is set for at least three major lines. Admiral, Sylvania and Hoffman. Zenith is promoting the 24-inch tube, and RCA and others have said they'll stick with 21 inches until they see which of the new larger sizes new-set buyers prefer.

Admiral joined Philco in showing a transistor portable TV receiver, but, unlike Philco, announced no plans for marketing such a set in the near future.

JAPANESE VACUUM TUBES join the growing list of "Made in Japan" products on the American market. A line of over 150 types of receiving tubes made by the Hitachi Co. is listed at about 25% under US prices. Another line made by the Nippon Electric Co. will sell at US prices through Channel-Master distributors. Already being imported in limited quantities are capacitors, resistors, hi-fi and other electronic equipment, in addition, of course, to widely sold transistor radios.

PARAMETRIC AMPLIFIERS are beginning to be commercially available. These low-noise high-frequency devices (described in detail in February, RADIO-ELECTRONICS, page 78) are now being supplied by Motorola's Military Electronics Div. in models for 220 and 450 mc.

INTERCONTINENTAL COMMUNICATION will be stepped up by the trans-Atlantic cable now being laid from Newfoundland to France. Two cables are being put down by a ship which proceeds at 8 miles an hour, paying out the 1¼-inch cables over its stern. The cable has electronic repeaters every 44 miles, and the sections of 250 miles each must be spliced at sea during laying operations. The 2,400-mile run will cost $40,000,000.

HUGO GERNSBACK AWARD for 1959–60 to an electrical engineering student of outstanding ability and promise of success in electronics was made to Patrick John Marino of Elmhurst, N. Y. Mr. Marino will be a senior at New York University, College of Engineering, next September. He is working during the summer as a junior engineer at the Sylvania Research Laboratories.

His interest in electronics stems from training he received in the U.S. Navy, from which he was discharged as an electronics technician, 1st class in 1956. Later he worked as a technician inspecting military gear for the Arma Corp. before entering NYU.

Mr. Marino experiments on his own a good deal, most recently having constructed an unique nonvacuum triode

(*Continued on page* 18)

What Does F.C.C. Mean To You?

What is the F. C. C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

What is an F. C. C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses—commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams"—people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

What are the Different Classes of RadiotelePHONE licenses?

Each type (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

Which License Qualifies for Which Jobs?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain, and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain, and operate every type of radiotelephone equipment (except amateur, of course) including all radio and television stations in the United States, and in its Territories and Possessions. This is the highest class of radiotelephone license available.

How Long Does it Take to Prepare for F. C. C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course*, the average beginner should prepare for his *second class* radiotelephone license after from 200 to 250 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course*, the time normally required to complete the course and get your license is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class*.

In the EVENING course (3 nights a week) you should get your *second class* license at the end of the 15th week of classes and your *first class* license at the end of 5 additional weeks of classes. This makes a total of less than 5 months required to cover the whole course, from "scratch" through *first class*, in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand—choose Grantham School of Electronics.

Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

HERE'S PROOF that Grantham Students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Ron Taylor, 29 S. Franklin St., Chambersburg, Pa.	1st	12
Beri Moore, P.O. Box 169, Opp, Alabama	1st	15
Donald R. Titus, 270 Park Terrace, Hartford 6, Conn.	1st	12
Robin O. Okinishi, P.O. Box 375, Hanapepe, Kauai, Hawaii	1st	12
Billy R. Kirby, Route #3, Smithfield, N. C.	1st	9
J. H. Reeves, 10621 Ruthelen, Los Angeles 47, Calif.	1st	12
Donald H. Ford, Hyannis Rd. (Cape Cod), Barnstable, Mass.	1st	12
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12

FOUR COMPLETE SCHOOLS

To better serve our many students throughout the entire country, Grantham Schools of Electronics maintains four separate Divisions — Hollywood, Calif.; Seattle, Wash.; Kansas City, Mo.; and Washington, D.C.—all offering the same courses in F.C.C. license preparation, either home study or resident classes.

For further details concerning F.C.C. licenses and our training, send for our FREE booklet, "Careers in Electronics". Clip the coupon below and mail it to the School nearest you.

Get your First Class Commercial F.C.C. License Quickly by training at

GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western Ave.	408 Marion Street	3123 Gillham Road	821 - 19th Street, N.W.
Hollywood 27, Calif.	Seattle 4, Wash.	Kansas City 9, Mo.	Washington 6, D.C.
(Phone: HO 7-7727)	(Phone: MA 2-7227)	(Phone: JE 1-6320)	(Phone: ST 3-3614)

MAIL COUPON NOW—NO SALESMAN WILL CALL →

MAIL TO SCHOOL NEAREST YOU

To: **GRANTHAM SCHOOL OF ELECTRONICS**

1505 N. Western HOLLYWOOD • 408 Marion SEATTLE • 3123 Gillham Rd. KANSAS CITY • 821 - 19th St., N.W. WASHINGTON

Gentlemen:

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

Name _____ Age _____

Address _____

City _____ State _____

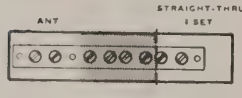
Interested in: ☐ Home Study, ☐ Resident Classes 94 M

MORE
PICTURE
POWER
new
BLONDER-TONGUE
B-24
POW-R
BOOSTER

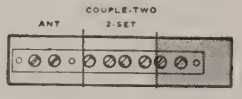
$24.95 list

it's a powerful booster
...or an amplified coupler!

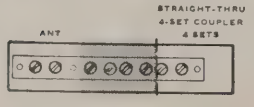
provides sharp, clear TV pictures on 1, 2 or more TV sets with only 1 antenna



'straight-thru' circuit provides up to 10 db gain as a powerful one-set booster



'couple-two' circuit provides up to 5 db gain (per set) as an amplified two-set coupler



'straight-thru' circuit and B-T 4-set coupler provide no-loss 4-set distribution system

Employs new frame-grid tube 6DJ8 new circuitry to achieve highest signal gain and "lower-than-cascode" noise factor. Provides full broadband amplification covering low and high VHF channels. May also be used as FM-TV coupler. Features "NO-STRIP" 300 ohm terminals for positive, electrical contact in seconds. Has "on/off" switch.
Improve TV reception today on 1, 2 or more TV sets with a single antenna.

Available at parts distributors. For details write RE-8
BLONDER-TONGUE LABORATORIES, INC.
9 Alling Street • Newark 2, N. J.
In Canada: Telequipment Mfg. Co., Ltd., London, Ont. **Export:** Morhan Export Corp., N. Y. 13, N. Y.
hi-fi components • UHF converters • master TV systems • industrial TV cameras • FM-AM radios

which worked in water. This "planar triode" produced frequency doubling and even a slight amount of gain. He is a member of the engineering fraternities of Tau Beta Pi and Eta Kappa Nu, and also of the IRE and AIEE.

Awarded each year by the faculty of the College of Electrical Engineering, the Hugo Gernsback Scholarship has a cash value of $1,000.

EDUCATIONAL TV now has a total of 43 stations on the air. Many of these program only 2 to 4 hours a day at present but their audiences are expanding and programs improving. The coordinating group for educational television, National Educational Television and Radio Center, recently moved its main office from Ann Arbor, Mich., to New York City. It received a grant of $5,000,000 from the Ford Foundation to strengthen educational TV, which bids fair to grow into a fourth network within a few years.

FIRST STEP TO INTERCONTINENTAL TV was the sending of a movie over the trans-Atlantic telephone cable. It was hailed as the first experimental transmission of "TV pictures" across the ocean. The British and Canadian Broadcasting networks cooperated with NBC to rush two 1-minute movies to the US audience of NBC. The 180 feet of movie film was shot as Queen Elizabeth left London to join President Eisenhower in opening the St. Lawrence seaway.

The film was processed. Then every second frame was scanned by a method developed by the BBC and NBC. Then it was sent over the 4,500-cycle intercontinental cable. Scanning and transmission took about 3 hours.

Although not quite true trans-Atlantic television, the system is 100 times as fast as present facsimile techniques.

APACHES RAN FAST to FCC with first reported application for vhf booster station. The Jicarilla tribe of Dulce, N. M., had its booster picking up and rebroadcasting on channel 4 the programs of KOB-TV, Albuquerque. The FCC replied that it's too early for booster applications. Indians also asked if they could send a representative to Washington for help with some of the problems they've been running into with monitoring and frequency control. END

WE'RE MAKING IT EASIER THAN EVER TO BECOME A WELL PAID

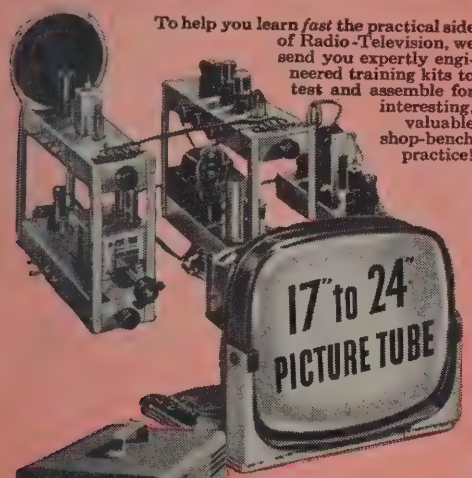
RADIO-TELEVISION SERVICE TECHNICIAN

NOW — Just $6 Starts You Training in RADIO-TELEVISION

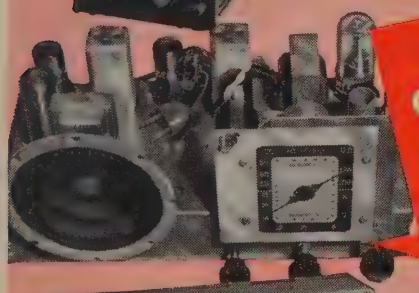
the SPRAYBERRY "Learn-by-Doing" Way . . .

25 BIG, COMPLETE KITS of PARTS & EQUIPMENT

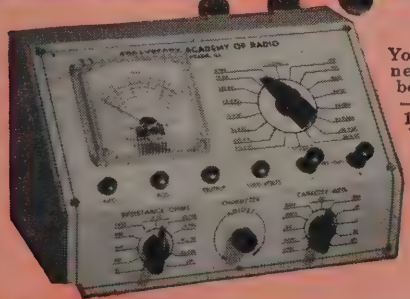
To help you learn *fast* the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!



- The new Sprayberry Training Television Receiver, built and tested in 5 sections.
- Now offered . . . this fine modern oscilloscope.
- You build this powerful two-band superheterodyne radio receiver.



Big New CATALOG AND Sample Lesson FREE!



You build the new Sprayberry tester—a complete 18-range Volt-Ohm-Milliammeter test meter.

★ ★ ★ ★ This great industry is begging for trained men . . . to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands... trained Radio-Television Service Technicians...are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need...to step into a fine job or your own Radio-Television Service Business.

Complete Facts Free—Act Now; Offer Limited

Only a limited number of students may be accepted on this liberal and unusual basis. We urge you to act at once...mail the coupon below and get complete details plus our big new catalog and an actual sample lesson—*all free.* No obligation...no salesman will bother you.

HOME STUDY TRAINING IN SPARE TIME

Under world-famous 27-year old Sprayberry Plan, you learn entirely at home in spare time. You keep on with your present job and income. You train as fast or as slowly as you wish. You get valuable kits of parts and equipment for priceless shop-bench practice. And everything you receive, lessons and equipment alike, is all yours to keep.

LET US PROVE HOW EASILY YOU CAN LEARN!

Radio-Television needs YOU! And Sprayberry is ready to train you on better, easier terms, that any ambitious man can afford. *Just $6 starts you!* Mail coupon today... let the facts speak for themselves. You have everything to gain. Let us prove the kind of opportunity that's in store for you!

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Mail This Coupon Now—No Salesman Will Call

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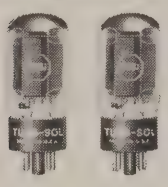
Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

NAME..... Age.....

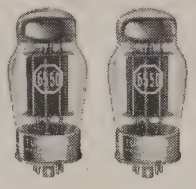
ADDRESS.....

CITY..... ZONE..... STATE.....

Tung-Sol audio tubes dynamically balanced and twin-packed in matched pairs by the manufacturer



5881 For service in amplifiers of up to 50 watts.



6550 For service in amplifiers and commercial audio equipment of up to 100 watts.

Now you can come as close to faultless sound reproduction as the design and circuitry of your hi-fi equipment will permit. Tung-Sol 5881 and 6550 beam-power amplifier tubes are dynamically balanced and factory-matched to very tight performance limits to help you achieve lowest distortion at all volume levels.

Use of Tung-Sol 5881 and 6550 tubes has long been associated with amplifiers of the very finest design. These tubes have always been produced to closest possible tolerances with cathode current ranges held to an absolute minimum.

Now, in twin-packed pairs, they assure the hi-fi enthusiast and the commercial sound engineer of replacement tubes that will provide new standards of performance — a feature of special importance with the newest amplifiers and loudspeakers, particularly binaural sound equipment. See your parts supplier.

Tung-Sol Electric Inc., Newark 4, New Jersey.

TUNG-SOL®

Correspondence

POLARIZED PLUGS

Dear Editor:

Re "Polarized Plugs," on page 33 of your June issue: I remember that a while back one of the electronic magazines [This one!—*Editor*] had an article about soldering a paper clip around the edge of one blade of an ordinary attachment plug to make it wider. This fixes the plug so it can be inserted only one way. I tried it and it works fine. But don't forget to check with a neon or other tester to make sure the wider slot is the grounded one! Very important!

GEORGE HRISCHENKO

Maidstone, Ont.

(The two-prong polarized plug has other weaknesses. Many pieces of equipment have the switch in the ground lead, for example. In such cases, a set may be safe when turned on and hot when turned off. For further details on two- and three-prong polarized plugs and general set safety, see "Death Rides the Hot Chassis," page 100, October, 1957, RADIO-ELECTRONICS.—*Editor)*

MORE ON GRAHAM'S THEORY

Dear Editor:

I've long been curious as to the true identity of Mohammed Ulysses Fips, but Capt. Graham's letter in your June issue has finally let the cat out of the bag! Surely the redoubtable M. U. F. is none other than Capt. Graham!

His suggestion that dead silence should come from the speaker opposite the singer's position on stage implies that both speakers must be silent when the singer is in the middle (a condition devoutely to be desired in the case of some singers!!), or that there be an infinity of speakers used to match every possible intermediate placement on stage.

RICHARD A. WALL

Riverside, Calif.

(There *is* a real Capt. R. F. Graham whose letter on page 18 of our June issue came to us unsolicited.—*Editor)*

Dear Editor:

Captain Graham must have a tin ear. Does he always sit fifth row center in the concert hall? Or does he have only one ear? If he has two, let him alternately cover and uncover one while listening to his wife, to see that sound actually does appear at the other ear, and must therefore be recorded at that volume and phase and reproduced in the corresponding speaker . . . Solists are usually placed in the center of the stage, *not at one side* . . . I suspect that "Capt. Graham" is a booby trap, that the editor wants to see who's paying attention!

W. C. WARE

Chicago, Ill.

Dear Editor:

In answer to Capt. Graham . . . recording and playing stereo as he suggests by spreading the orchestra in two rooms . . . would lose the third dimension which is the great value of stereo. This is what is called depth. And depth comes from using two or more microphones in the same room. A singer at stage right is picked up directly by the right microphone, and a few micro seconds later by the left microphone. These two signals, later re-created by speakers spaced similarly, gives us the depth. Obviously even more channels would sound better.

RICHARD LASIUK

Thorp, Wis.

PRO-COOPER'S EARS

Dear Editor:

George Cooper's excellent article on Golden Ears could have been even stronger if the author had realized and mentioned the fact that no music exists which has audible overtones above 9,408 cycles, as Dr. Fritz Kuttner pointed out in *The High Fidelity Reader* (edited by Roy Hoopes).

Tests showing hearing from 15,000 to 20,000 cycles refer to *sound* at the level of the threshold of *pain*, not to music at actual listening levels.

NORMAN ARLINGTON

Gulfport, Fla.

8AP4's ANYONE?

Dear Editor:

I wonder if any of your readers has an 8AP4 cathode-ray tube in working condition lying around his shop? Or an Arvin deflection yoke with the numbers C-24283 in the junkbox? Drop me a card and I'll buy. . . . Thanks.

WALTER A. KOEHLER

131 Stratford Drive
Houghton Lake 12, Mich.

ATWATER KENTS AND PARTS

Dear Editor:

I have an Atwater Kent model 36, serial 2606628, and a model 20, serial 311801, both in top condition—the 20 is in its carton and has never been used. Can you tell me what tubes it

SAVE 1/2 THE TIME

Make Twice The Profit!

in TV Trouble-Shooting

THIS EASY
SIGNAL INJECTION
POINT-TO-POINT
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New Technique Makes TV Servicing Easier, Faster, More Profitable

Thousands of service technicians already save thousands of hours every day with the amazing B&K Television Analyst. Enables you to inject your own TV signal at any point and watch the resulting test pattern on the picture tube itself. Makes it quick and easy to isolate, pin-point, and correct TV trouble in any stage throughout the video, audio, r.f., i.f., sync, and sweep sections of black & white and color television sets—*including intermittents.* Makes external scope or wave-form interpretation unnecessary. Enables any serviceman to cut servicing time in half, service more TV sets in less time, really satisfy more customers, and make more money. Color generator provides both rainbow pattern and color bars.

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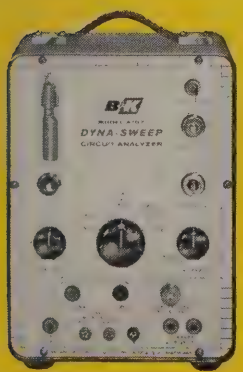

NEW Model A107
DYNA-SWEEP
CIRCUIT ANALYZER

Saves many hours of service work. Provides vertical and horizontal sync and driving pulses that enable you more easily and quickly to check out every stage in the sync and sweep sections of a television receiver.

Tracks down troubles in the horizontal and vertical output circuit including defective output transformer and yoke; checks for shorted turns, leakage, opens, short circuits, and continuity. Includes unique high-voltage indication. Eliminates trial and error replacements.

Model A107 Dyna-Sweep. Companion unit for use only with B&K Model 1075 Television Analyst for driving source. **Net, $49.95**

Model 1070 Dyna-Sweep. Same as Model A107 but has its own horizontal and vertical driving pulse, and is used independently of the Model 1075. **Net, $69.95**

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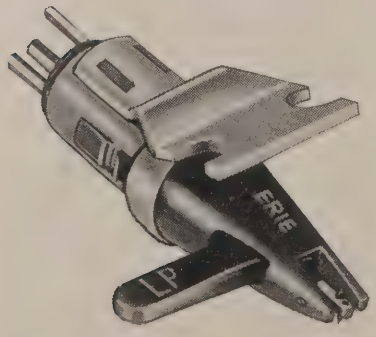

See your Erie Distributor for the complete-in-one-box Erie "PAC" Kit. Also ask him to show you the new Erie *single*-element ceramic stereo cartridge with the simplest construction and the highest-fidelity characteristics.

For the name of your nearest Erie Distributor, write to:

ERIE Electronics Distributor Division
ERIE RESISTOR CORPORATION
Erie, Pennsylvania

uses, when these sets were made, and if they're worth anything as collectors' items?

Also, I have several hundred parts for Atwater Kents of the 1920's, many in original cartons; coils, dials, tubes, tuning condensers, switches, controls, cases, hardware and power supplies. Also some metal-cased A-K's. Any market for these?

JAMES STEGNER
R.D. 1, Mount Zion
Clearfield, Pa.

(Mr. Stegner's query regarding the tubes has been answered. Do any of our readers know when the sets were built? Or want any of his Atwater Kent power supplies, parts or sets? —*Editor.*)

SOLDERING NOTES

Dear Editor:

I have been trying to find time to comment on Mr. Darwin H. Harris' article "Notes on Soldering" which appeared on page 58 of RADIO-ELECTRONICS, November, 1958.

Most interesting was the writer's using his head and trying something different instead of following the time-honored rule of making the joint mechanically sound before soldering.

Mr. Harris would be gratified to read an article titled "Reliable Soldered Connections Without Mechanical Joints" by J. Roy Smith, Head, Reliability and Standards Branch, US Navy Electronics Laboratory, San Diego, Calif. The article starts on page 143 of the September, 1956, issue of "*Electrical Manufacturing.*"

The article is a report on an exhaustive investigation of soldered connections where pigtails were only poked through the hole of a lug or bent part way around a turret terminal — just enough to keep them from falling off. The board wired up with a number of components in this manner, poorly supported mechanically but well soldered, was put through all the military tests for vibration, shock, acceleration, heat, humidity, etc., and not one soldered connection failed. However, some of the heavy components like paper capacitors tore loose under the punishment, leaving their pigtails behind, still securely soldered.

Then they tried the same test with the component pigtails laid across the tips of vertical wires and soldered with a bare minimum of solder. A few joints broke loose but the majority held. Several different grades of solder were also tried without noting very much of any difference.

I too have learned quite a lot about soldering in the 35 years which have passed since I wired my first 3-tube set with acid-core solder. I was demonstrating it and just about had the name on the dotted line when it quit. I have never forgotten what a job it was to redo all those corroded connections.

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"The native Hollander wears wooden shoes."

"Nebraska has no seacoast."

"The daisy is a common wildflower."

As these syllables, words and sentences come in over the telephones, stand-ins for millions of Bell System subscribers rate them for clarity of reception.

From these tests, Bell Telephone Laboratories engineers determine what is objectionable noise, and work to minimize it in telephone circuits. They begin by tape recording background noise associated with working telephone circuits. Test statements of appropriate length and content (such as those above) are read onto a second tape, and both are fed onto the test circuit under carefully controlled conditions. A third tape, of normal room noise, is played through a loudspeaker in the test lab.

Several hundred listeners, meeting in small groups several times a day for weeks at a time, are then asked to rate the effect of noise on transmission of the various simulated telephone calls.

For the Bell System, the results of the study will become part of the over-all transmission objectives. At Bell Laboratories, they will influence apparatus and systems development work.

Noise is a major distraction of modern day living. It is also an enemy of the Bell System. In a telephone receiver during a call, it might be power line hum, switching or thermal noise, or perhaps atmospheric static. Bell Laboratories spends a great deal of time, effort and money to keep this extraneous noise from becoming annoying and to assure you of a trouble-free connection.

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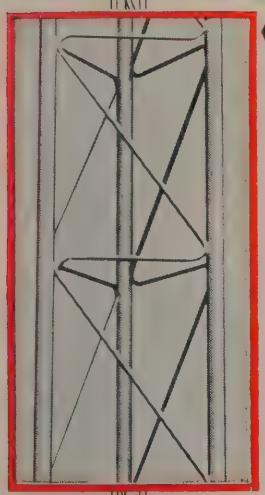
TOWERS



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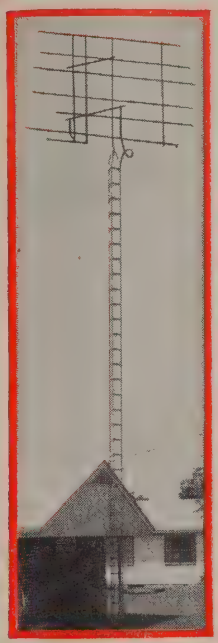
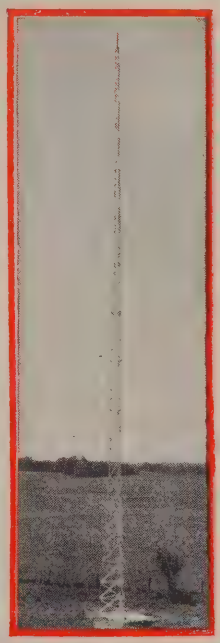
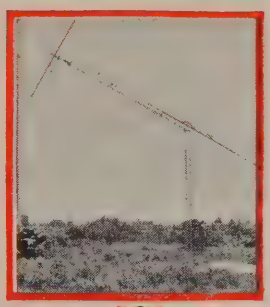
No. 6 This ROHN tower features the well-known "magic triangle", the cross-bracing construction that is unequalled in strength and durability. Also available self-supporting, or guyed to about 150 feet.







Fold-over The No. 25, as well as heavy-duty No. 40 communication tower, can be converted into "fold-over" towers for amateur use . . . the *only* tower of its kind. They let you work "on the ground!"

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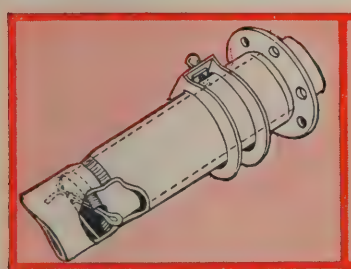
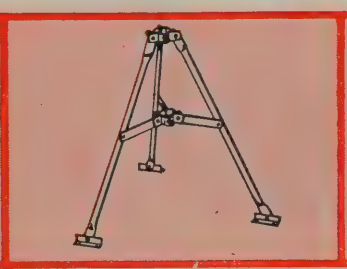
FIVE complete lines of communication towers are available to fulfill *practically any need*, including a 130 foot true heavy-duty communication tower that is completely self-supporting and guyed models up to 600 feet!

Complete communications catalog sent on request!

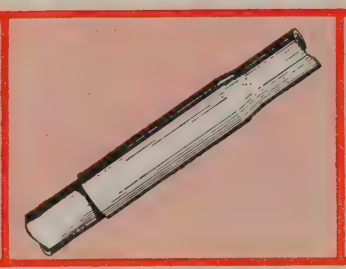
PLUS ALL THESE ROHN DESIGNED ITEMS



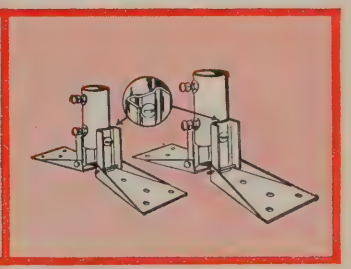
Telescoping masts—Unexcelled in design, structure and strength, with several exclusive features! All popular sizes, heights and weights available.



Roof towers—Available in 10, 5 and 3 foot heights. Most of them are collapsible for easy shipping. Ideal in use—a ROHN "big-seller".



Tubing—Just what you want: 6" expanded end with ½" taper to form a solid locking joint! High carbon steel. Available 5, 10 foot lengths, 1¼", 1½" diameter, 16 and 18 gauge.



Bases—Wide variety of roof mount bases. Special locking feature. Also available is cast aluminum roof mounts and many other types.

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Matched Pairs for Higher Fidelity

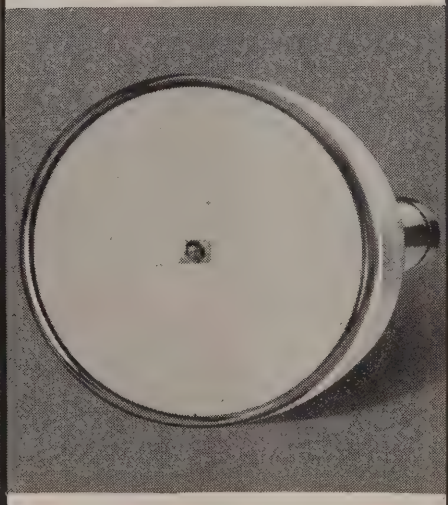
Typical of premium-performance CBS receiving tubes are these audio output tubes. Their critical audio characteristics are matched to help minimize harmonic distortion in push-pull amplifiers. The 6BQ5, 6V6GT, 5881 and 6550 matched pairs reduce distortion even below that attainable by controls for balancing plate currents.

Professional 55 Stereo Cartridge

This is the professional's version of the popular Columbia CD. Designed for transcription turntables, it uses a .5-mil diamond stylus, and features superior linearity . . . separation . . . needle-point impedance . . . low mass . . . freedom from hum and distortion . . . output level . . . ruggedness. Includes 4 plug-in equalizing networks. Another fine Columbia audio component.

Premium or Budget TV Tubes

A CBS original! Sell your customer whichever he wants: premium-performance CBS Silver Vision or budget-priced CBS Palomar. Either is easy to sell because of top brand prestige. Either stays sold because of top performance in its field. Recommend these dependable national-brand CBS picture tubes with confidence.

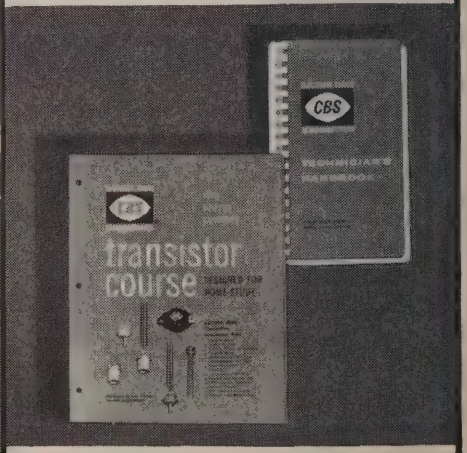


Ultrahigh-resolution C-R Tubes

New UHR tubes offer still another addition to CBS industrial tubes . . . most inclusive line in the industry. They can compress into 1/20 square inch all detail on the face of a 21-inch picture tube. They make practical many advanced military and industrial applications requiring resolution beyond the capabilities of the unaided human eye.

New Semiconductor Lines

Drawing on its experience in NPN switching transistors and PNP power transistors, CBS Electronics now adds a comprehensive group of NPN power transistors for use in complementary circuits. Its line of NPN switching transistors has been more than doubled to meet increasing demands by computer manufacturers.



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Expanded CBS Transistor Home-Study Course (still only $25.00) makes it easy to learn about transistors by making practical transistor devices from readily available parts. Opens up advancement opportunities. 1959 Technician's Handbook, designed for the technician, is compact, handy, modern. Its 550 pages include receiving, picture, special tubes and semiconductors . . . only $1.85. See both at your distributor's.

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Stereo Preamplifier HF85
FM Tuner HFT90
AM Tuner HFT94
Stereo Amplifier-Preamp HF81
Monaural Integrated Amplifiers: 50, 30, 20, and 12-Watt (use 2 for Stereo)
Bookshelf Speaker System HFS1
Omni-directional Speaker System HFS2 36" H x 15¼" W x 11½" D
Monaural Preamplifiers: HF65, HF65A (stack 2 for Stereo)
Monaural Power Amplifiers: 60, 50, 35, 30, 22 and 14-Watt (use 2 for Stereo)
Stereo Power Amplifier HF86
MEMBER HIGH FIDELITY MANUFACTURERS INC.

Over 1 MILLION EICO instruments in use throughout the world.

NEW STEREOPHONIC EQUIPMENT

NEW AF-4 Complete Stereo Dual Amplifier (not illus.) provides **clean** 4W per channel or 8W output. Usual solid EICO construction & trouble-free design. Inputs for ceramic/crystal stereo pickups, AM-FM stereo, FM-Multi stereo; 6-position stereo/mono mode selector; clutch-concentric level & tone controls. 27db of feedback around each power amplifier reduces distortion to 0.3% at normal listening levels with hi-efficiency speakers (Norelco AD4877M or equivalent recommended). Kit **$38.95.** Wired **$64.95.**

HF85: Stereo Dual Preamplifier is a complete stereo control system in "low silhouette" design adaptable to any type of installation. Selects, preamplifies, controls any stereo source — tape, discs, broadcasts. Superb variable crossover, feedback tone controls driven by feedback amplifier pairs in each channel. Distortion borders on unmeasurable even at high output levels. Separate lo-level input in each channel for mag. phono, tape head, mike. Separate hi-level inputs for AM & FM tuners & FM Multiplex. One each auxiliary A & B input in each channel. Independent level, bass & treble controls in each channel may be operated together with built-in clutch. Switched-in loudness compensator. Function Selector permits hearing each stereo channel individually, and reversing them; also use of unit for stereo or monophonic play. Full-wave rectifier tube power supply. 5-12AX7/ECC83, 1-6X4. Works with any high-quality stereo power amplifier such as EICO HF86, or any 2 high quality mono power amplifiers such as EICO HF14, HF22, HF30, HF35, HF50, HF60. **"Extreme flexibility . . . a bargain"** — HI-FI REVIEW. Kit **$39.95.** Wired **$64.95.** Includes cover.

HF86: Stereo Dual Power Amplifier for use with HF85 above or any good self-powered stereo preamp. Identical Williamson-type push-pull EL84 power amplifiers, conservatively rated at 14W, may be operated in parallel to deliver 28W for non-stereo use. Either input can be made common for both amplifiers by Service Selector switch. Voltage amplifier & split-load phase inverter circuitry feature EICO-developed 12DW7 audio tube for significantly better performance. Kit **$43.95.** Wired **$74.95.**

HF81: Stereo Dual Amplifier-Preamplifier selects, amplifies & controls any stereo source — tape, discs, broadcasts—& feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Monophonically: 28 watts for your speakers; complete stereo preamp. Ganged level controls, separate focus (balance) control, independent full-range bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers, excellent output transformers. "Service Selector" switch permits one preamp-control section to drive the internal power amplifiers while other preamp-control section is left free to drive your existing external amplifier. **"Excellent"**—SATURDAY REVIEW; HI-FI MUSIC AT HOME. **"Outstanding quality . . . extremely versatile"** RADIO & TV NEWS LAB-TESTED. Kit **$69.95.** Wired **$109.95.** Includes cover.

MONO PREAMPLIFIERS (stack 2 for STEREO)

HF-65: superb new design. Inputs for tape head, microphone, mag-phono cartridge & hi-level sources. IM distortion 0.04% @ 2V out. Attractive "low silhouette" design. **HF65A** Kit **$29.95.** Wired **$44.95. HF65** (with power supply) Kit **$33.95.** Wired **$49.95.**

MONO POWER AMPLIFIERS (use 2 for STEREO)

HF60 (60W), HF50 (50W), HF35 (35W), HF30 (30W), HF22 (22W), HF14 (14W): from Kit **$23.50.** Wired **$41.50.**

MONO INTEGRATED AMPLIFIERS (use 2 for STEREO)

HF52 (50W), HF32 (30W), HF20 (20W), .HF12 (12W): from Kit **$34.95.** Wired **$57.95.**

SPEAKER SYSTEMS (use 2 for STEREO)

HFS2: Natural bass 30-200 cps via slot-loaded 12-ft. split conical bass horn. Middles & lower highs: front radiation from 8½" edge-damped cone. Distortionless spike-shaped super-tweeter radiates omni-directionally. Flat 45-20,000 cps, useful 30-40,000 cps. 16 ohms. HWD 36", 15¼", 11½". **"Eminently musical"**—Holt, HIGH FIDELITY. **"Fine for stereo"**—MODERN HI-FI. Completely factory-built: Mahogany or Walnut, **$139.95;** Blonde, **$144.95.**

HFS1: Bookshelf Speaker System, complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. Capacity 25 w. 8 ohms. HWD 11" x 23" x 9". Wiring time 15 min. Price **$39.95. LGS-1 Brass Tip Matching 14" Legs** easily convert HFS-1 into attractive consolette. All brackets & hardware provided. **$3.95.**

FM TUNER HFT90: A superior **stable** tuner easy to assemble — no instruments needed. Prewired, prealigned, temperature-compensated "front end" is **drift-free,** eliminates need for AFC. Prewired exclusive precision **eye-tronic®** traveling tuning indicator contracts at exact center of FM channels. Prealigned IF coils. Sensitivity 6X that of other kit tuners: 1.5uv for 20db quieting; 2.5uv for 30db quieting, full limiting from 25uv. IF bandwidth 260kc at 6db points. Frequency response 20-20,000 cps ±1db. 2 output jacks: cathode follower to amplifier, Multiplex output for FM Multiplex Stereo adapter; thus prevents obsolescence. Very low distortion. **"One of the best buys in high fidelity kits"** — AUDIOCRAFT. Kit **$39.95*.** Wired **$65.95*.** Cover $3.95.

*LESS COVER, F.E.T. INCL.

NEW AM TUNER HFT94: Matches HFT90. Selects "hi-fi" wide (20c — 9kc @ —3 db) or weak-station narrow (20c — 5kc @ —3 db) bandpass. Tuned RF stage for high selectivity & sensitivity; precision **eye-tronic®** tuning. Built-in ferrite loop, prealigned RF & IF coils. Sensitivity 3 uv @ 30% mod. for 1.0 V out, 20 db S/N. Very low noise & distortion. High-Q 10 kc whistle filter. Kit **$39.95.** Wired **$69.95.** Prices incl. Cover & F.E.T.

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shows you HOW TO SAVE 50% on 50 models of top quality professional test equipment.

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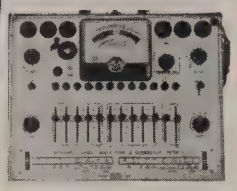

NEW! DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666

KIT $69.95 WIRED $109.95

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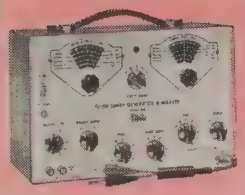

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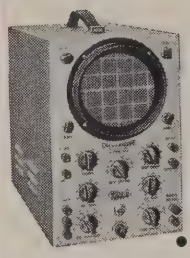

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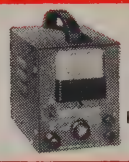

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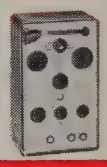

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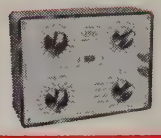

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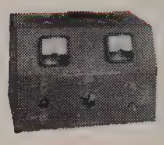

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LETHAL RADIO WAVES

. . . We Must Reappraise the New Effects of Radio Waves . . .

LATELY, new and unexpected physiological radio-frequency effects, which may add an entirely new phase to our knowledge of the electromagnetic spectrum, have been discovered. This development may have a far-reaching influence in many directions.

As far back as 1953 we reported on this page the experiments of Sidney I. Brody, Commander (MC), US Navy.* For sake of completeness of the present report, we excerpt only a few paragraphs here:

"Present-day radar beams represent peak pulsed power of a million watts or over, as compared to the 45,000 watts of a decade ago.

"Commander Brody observed that the two frequency spectra, the S or 10-centimeter and the X or 3-centimeter bands, are now in current use. He stated that the effect on living organisms of the various frequencies of electromagnetic waves in these bands are thought to be essentially thermal in nature. It is not known so far whether there might be other than heat effects when living organisms are exposed to these radiations.

"It has been noted that the 3-centimeter radiations used today in radar equipment can produce high thermal effects. The energy seems to be absorbed *near the surface of the skin.* When the power output becomes sufficiently high or if there has been long exposure to the radiation, the subject receives ample warning due to the high heat generated on the body. It is therefore thought that the 3-centimeter radiations do not seem to constitute a hazard for the exposed personnel. However, on frequencies in the vicinity of 10-centimeters the conditions change because the high temperatures in this case occur about 1 centimeter *below* the surface in organs not cooled by the blood stream. Since the skin is not stimulated by this heat, the subject does not perceive heat nor pain—he no longer has any warning. Therefore, the 10-centimeter radiations become dangerous.

"Commander Brody observed that areas of the body possessing a poor blood supply have no effective temperature-regulating mechanisms, as in the lens of the eye, the hollow organs, the gall bladder, the urinary bladder and parts of the gastrointestinal tract. These are potential danger points for the 10-centimeter radiations.

"Rabbits exposed to constant power in a 3,000-watt field for 75 seconds were killed, while a 30-second exposure produced death in 2 minutes. Instant death to a rat resulted after only 22 seconds' irradiation at that power, and 10 seconds of a 4,000-watt constant power output killed a hamster soon after exposure. In these animal experiments, high increases in body temperature produced heat paralysis of the respiratory centers."

Recently, Dr. Pearce Bailey, of the National Institute of Neurological Diseases and Blindness at Bethesda, Md., revealed a new "remarkable phenomenon," as he termed it.

A commercial 100-watt radio transmitter, working at a frequency of 388 mc, was used in Dr. Bailey's experiments. A Rhesus monkey was so fastened that his head was surrounded by a cylindrical copper-screen cavity. This cavity was fed at top center by a quarter-wave vertical probe, connected to the transmitter output. Thus nothing touched the monkey. Says Dr. Bailey:

"The switch was turned on and during the first few seconds the monkey did nothing other than sit in a pose of watchful waiting. Then he became drowsy. A minute or so after that he became aroused, alert and somewhat agitated, moving his head from side to side.

"Then in another minute or more there appeared unmistakable signs of some impending disturbance in the vital centers of the monkey's brain, which were probably resonating with these electromagnetic waves. His nose became red, his skin was pallid, and an anxious look dominated his eyes.

"He grimaced and smacked his lips, his eyelids began to quiver and he developed a rapid, vertical motion called a vertical nystagmus of the eyeballs, the pupils of which were widely dilated. His respirations became more and more irregular, he began to salivate and suddenly was thrown into a major convulsion a few seconds before his death, his life having been extinguished like the snap of a light bulb."

In about 5 minutes, Dr. Bailey reported, the monkey unexpectedly died. About 20 other monkeys were similarly tested but the exposure was halted in the cases of about half before they died. Most survivors recovered, although they originally showed signs of brain damage.

Dr. Bailey suggested that the molecules of the animal's brain may have been destroyed when they "resonated" with the radio frequency of the nearby transmitter. A similar phenomenon occurs when certain sound waves shatter glasses when the audio note has the same fundamental frequency as that of the glasses. He also commented on the effect of radio waves under proper dosage in the treatment of brain disorders.

More recently, Dr. John Heller, of the New England Institute for Medical Research, demonstrated that radio waves below 50 megacycles "shake up living cells" profoundly.

Until further physical facts about various radio-frequency phenomena have been investigated more comprehensively, one thing seems certain to most physicists. There is no deleterious effect of radio waves, unless the subject—whether live or inert—is in the immediate vicinity of the transmitter.

Indeed, the effect may not be lethal even if a person is close to certain transmitters. Thus diathermy, the use of high-frequency waves in the region of 100 megacycles (3 meters), to generate heat in the living tissue for therapeutic purposes has been known and used extensively since the 1920's.

We may be certain that other frequencies will be discovered that have as yet unknown beneficial therapeutic effects in the treatment of various diseases.

So far, for instance, the millimeter frequencies down into the optical region have not yet been extensively explored, chiefly because of the lack of sufficiently powerful transmitters.

For military purposes, intensive work is now in progress to discover suitable frequencies with massive power which could be pin-pointed on missiles while in flight. The underlying thought here is that if a sufficiently powerful beam of radio frequency could intercept an atomic missile while in flight, it could affect the molecular structure of the bomb, either by direct radio-frequency or thermal effect, or both, thus exploding the missile anywhere from 10 miles up. This then would constitute a perfect anti-missile counter (always presuming that such a beam, or beams, could sufficiently penetrate the heavy metal casing of the A- or H-bomb). Yet the idea is not as impossible as it may appear at the moment. —*H. G.*

* See editorial "Radar Hazards" in the August, 1953, issue of RADIO-ELECTRONICS.

SERVICING ELECTRONIC ORGANS

Any good electronic technician can repair and tune an electronic organ—if he starts off in the right direction. A few simple facts point the way

By TOM JASKI

Baldwin A5 organ console and Deagan chimes.

THE service technician who feels that a saturation point may have been reached for service work in his community may still find a huge market for his work in an uncrowded, well paid and interesting field. I am speaking of maintaining electronic organs.

For one who is accustomed to repairing audio equipment and tracing faults in complicated television receivers, the electronic organ presents no special difficulties. Organ circuits are all audio types, and usually not very complicated. However, there are a lot of them in each organ.

Electronic organ service is strictly a home-call business. You can't very well pack organs in a truck and take them to the shop for repair, although this has been done with some of the smaller models.

Before you get into this, let me warn you against some of the pitfalls I learned the hard way—by experience. People who have bought an organ recently (within the past year and a half) are usually unsure of themselves as far as the works of their instrument is concerned, and love to talk to someone who they think knows all about it. They can keep you talking for hours, if you are willing. This could cut down your calls from eight or nine a day to maybe four or five, and you'll soon be out of business. The best attitude is to be friendly but firm. Get there when the customer expects you. Find the trouble. Then fix it and run. It is important on home calls to make a precise date (time and day). Fixing organs can involve a good deal of noise, and you may be in the way if you arrive when a bridge party has started or right after the baby has been put to bed. You may even have to make a second call.

If the customer wishes the organ tuned, include a small additional charge. Tuning some models can be a tedious and time-consuming job, a very simple one on others. Work out an average time for tuning over a period of months, and base your charge on your own experience. More about this later.

To avoid wasting time, never let the customer know you can play an organ, even if you are an accomplished organist. You might find yourself giving an impromptu organ lesson or demonstrating the capabilities of the instrument.

If you are not now repairing organs, the first step is to find out what organs are sold in your community, and who the dealers are. Introduce yourself to them, and declare your intentions. Some may be only too happy to find someone willing to repair and tune their instruments. If they already have someone for the work, this is the quickest way to find out.

If you make an agreement with the dealer, get his assistance in obtaining service manuals. Some organ companies are reluctant to send out such manuals. One, the Allen Co., gets downright stubborn about the matter. They insist on factory-trained service technicians.

The dealer can also give you the names of organ owners in the community, something you will need for your advertising campaign once you get started seriously. Another useful group of people to get acquainted with is the local organists for the churches that use electronic organs. You can get their names from city directories, telephone directories and, if there is one, from the local branch of the American Guild of Organists.

What and where are they?

There are a lot of electronic organs on the market. Offhand I can think of the Baldwin, Hammond, Conn (formerly Consonata), Wurlitzer, Gulbransen (transistorized), Minshall, Lowrey, Thomas, Kelley, Allen, Wells and Compton organs and such semi-organs as the Hammond and Wurlitzer chord organ, the old Novachord, and the piano-attached Solovox and Lowrey Organo. Then you may come across the old Everett Orgatron, the forerunner

of the Wurlitzer combination reed–electronic organs. You may have to deal with the Wurlitzer electronic piano, and such additions to organs as the Maas-Rowe chimes, the Zimbalstern (an electric bell ringing deal) and various other traps and attachments.

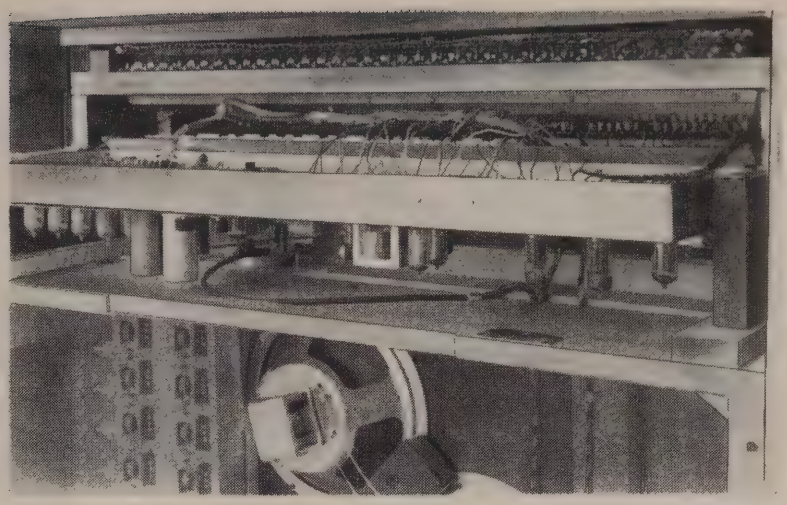
Finally, some of the modern pipe-organ builders have been using electronic tone generators and amplifiers for the lowest notes. Some of the large Casavant organs built in California by Dick Stenger have electronic notes in the pedal base. The reason for this is economy. The most expensive pipes in a pipe organ are obviously the largest ones. More than 75% of the cost of a pipe organ are the pipes below middle C. By making the lowest of them electronic, a lot of money can be saved. The notes are so low that no one can distinguish properly built electronic pipes from the real thing anyway.

Where can you find electronic organs? First of all in homes, where the great majority of them are. Next you'll find them in churches, funeral parlors, school and civic auditoriums, lodge halls, movie theaters, bars, restaurants, broadcast studios, and even on ocean liners, private yachts and in house trailers. I have seen them in hospitals, houseboats and national park lodges in various parts of the country. Large hotels may have several stored for occasions and department stores use them during fashion shows. I dare say you'll find some in unexpected places. I once saw one being used in a railway waiting room during the Christmas holidays. Wherever organs are being used you may have to go to repair them on the spot.

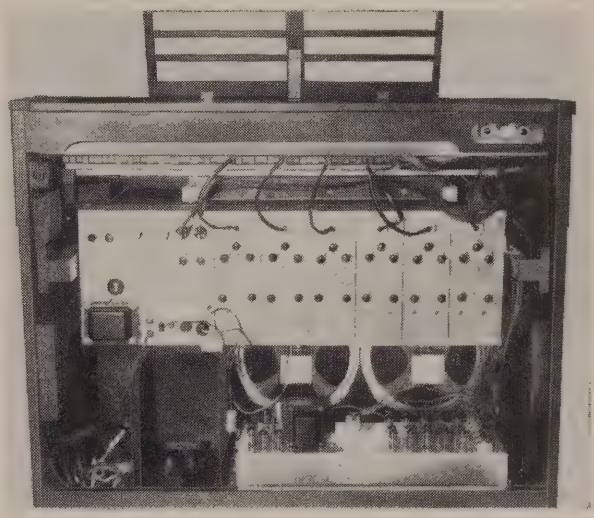
There are no accurate statistics that I know of, but you can be certain that the electronic-organ market is growing by leaps and bounds. New organ companies are springing up all the time. Once bought, an organ is something that lasts, and is a perpetual potential opportunity for service work. There are hundreds of thousands in the homes of the country now.

What tools are needed?

The tools and instruments you use to do an efficient home-call repair job on hi-fi equipment will just about do for organ repair work, except for a few small extras you can make for yourself. At a minimum you should have a portable tube checker (preferably a transconductance type), a vtvm or sensitive multimeter (100,000 ohms per volt) and the necessary hand tools. A portable scope with enough response to cover the audio range comfortably and with at least 100-mv-per-inch sensitivity is helpful, but not absolutely essential. Make sure you have long test leads on both scope and meter. An organ is a large instrument, and you may have to reach quite a way with the test prods. Use clips on the ends of your



The Hammond Chord Organ chassis swings down for easy servicing.



The chassis of the smaller Baldwin organ, the Orgasonic, contains all the tone generators. Master oscillators and power amplifiers are on the lower chassis. Speakers are self-contained.

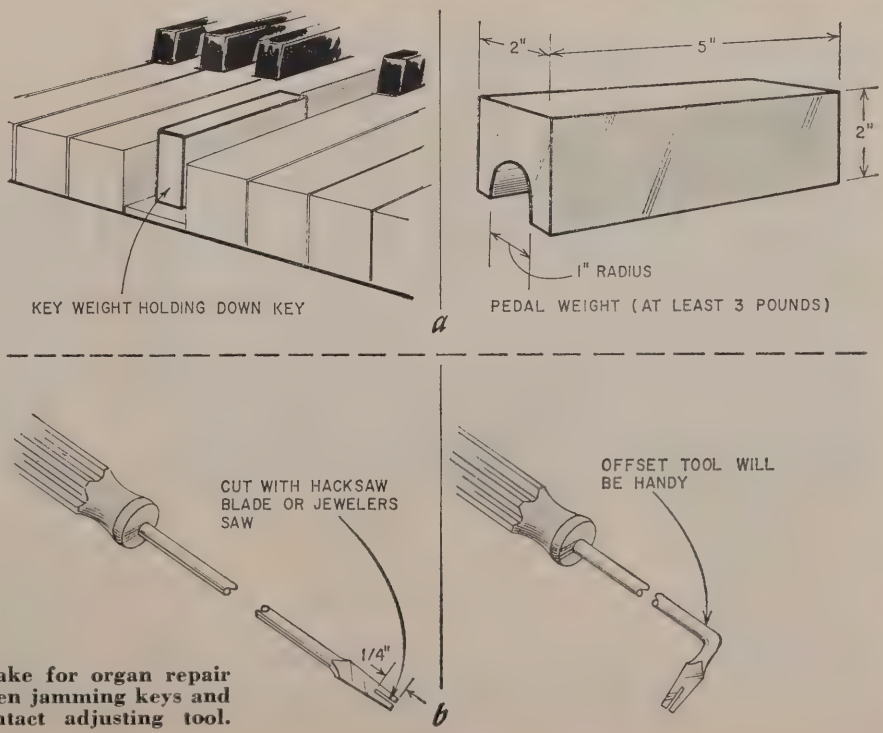


Fig. 1—Simple but useful tools you can make for organ repair work: a—key and pedal weights are better then jamming keys and pedals with pencil or screwdriver; b—contact adjusting tool.

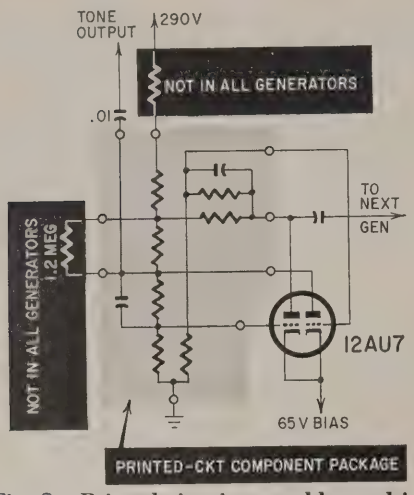


Fig. 2—Printed circuit assembly used in tone generator of Lowrey organ. Note that some external resistors had to be used. These resistors are not used in all generators.

leads, so both hands are free to make adjustments.

Unless you have perfect pitch (the ability to reproduce vocally any note upon request), you'd better carry a tuning fork, either A (440 cycles) or C (261 cycles). You'll need them for tuning. Alternatively, you might be able to use a pitch pipe such as violinists and other musicians may use to tune their instruments. But make sure the pitch pipe is a good one; accurate, and well constructed so it stays on pitch. You might have to check a pitch pipe occasionally. An audio oscillator may sometimes help, but I seldom need one when servicing organs.

Carry a cloth or small blanket to avoid scratching polished console surfaces. You're supposed to leave the organ in *better* shape than you found it. Finally the specials. Make two lead or iron weights, narrow enough to put on a key to hold it down. Wrap the weight in tape or cloth, preferably felt, to avoid scratching the keys. Then make one or two much heavier weights which will sit on pedals (pedals are rounded on top) and hold them down. This way you will not have to have someone hold down keys for you when tuning or checking.

Finally, you should have a set of two or three small tools like the ones a telephone repairman uses to adjust relay contacts. You need them for the same purpose, adjusting relay contacts or the contact arms of key and pedal switches.

These small tools can be made from old screwdrivers. Use a hacksaw with a narrow blade to cut the slots (see Fig. 1). These just about complete the list of tools you will need. If any organ requires special tools for service, the manual will tell you about them. Service manuals, it goes without saying, are your most important tool. If you cannot get the data on some of the organs, try the series "Electronics and Music" by Dorf, starting with the July 1950 issue of RADIO-ELECTRONICS, and going well into 1952. Dorf gives a lot of details about various organs on the market at that time, but there are several new types out now.

[All issues containing articles in the series are out of print. However, most of the information in the articles will be found in Dorf's book *Electronic Musical Instruments,* Schober Organ Corp., 2248 Broadway, New York 24, N. Y. —*Editor*]

Each make of organ has its own peculiarities. To begin with, you should carry at least two of each type of tube used in the organ you are about to service. Then you'll need an assortment of capacitors, resistors and such things as fuses and pilot lamps. Some organs use special parts, like the printed circuits in the Lowrey (see Fig. 2). If your customers have many of these organs, by all means stock some of the parts. I used to bypass the printed circuits with conventional parts, when necessary, but it is sometimes difficult to do. You may have to replace all the parts contained in the printed circuit. After a while you will become familiar with the tricks the various organs play most often, and be able to reduce the load you carry on your calls. Even so, all you need in a day can fit into a small car.

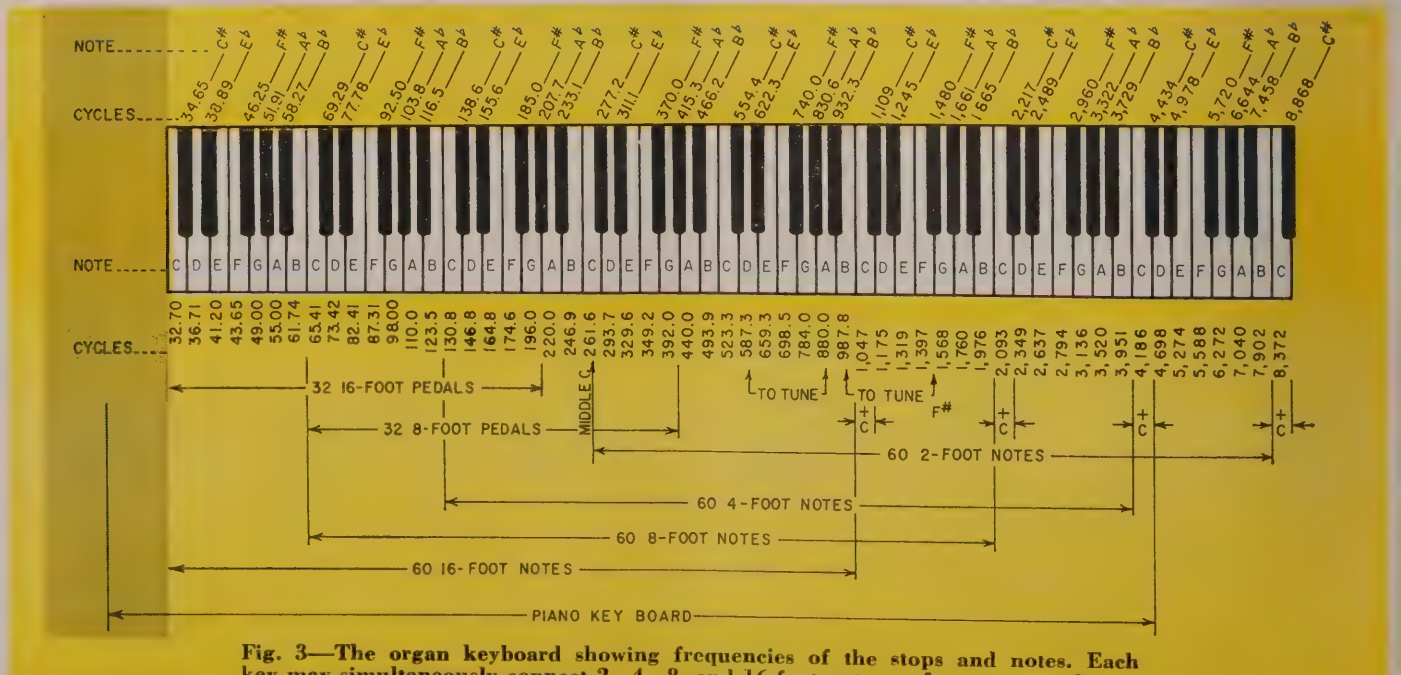
What should you charge for a call? I get a minimum of $10, with parts extra. This pays for travel time and costs. An electronic organ represents an investment of from $1,000 to $65,000 for some of the bigger church organs. The owner will be willing to pay reasonably well to protect his investment.

Once you have built up confidence in your work, you may be able to contract for regular monthly maintenance for a fixed fee plus parts. Many churches prefer this arrangement. There is nothing quite so disturbing to the mood of a religious service as an organ conking out in the middle of a hymn. If you accept such contracts, you will also be responsible for keeping the organ tuned. Let me warn you that you may have to work on Saturday nights and early Sunday mornings, before the first church services start. Incidentally, some mutual-assistance pact with a pipe-organ builder and service technician may well be advantageous for both.

What is in an organ?

There isn't enough space to give you a complete course on how to troubleshoot the various organs. But I can give you a general outline and some hints.

Most electronic organs, except for


NOTE
CYCLES
C# D# F# A# C C# D# F# A# C C# D# F# A# C

the very large Allens, are self-contained. The console has one or more keyboards or manuals of 61 keys each, a set of stop tabs for each manual and 32 pedals, also with stop tabs. The stop tabs are used to select the tones desired from each set of keys. Home organs often have only 12 pedals and no selection of stops for them. Chord organs have shorter manuals, two pedals (high and low) and a set of chord buttons which let the player sound a whole chord with the high pedal and its base note with the low pedal.

The keys and pedals have contacts which connect certain tone oscillators to a common bus and feed the signals on through formant circuits, where they are shaped into the desired timbre, then amplified for loudspeaker reproduction. Most organs use frequency-divider systems. They have 12 master oscillators, one each for each note in the top octave of the organ, and dividers for the other 5 to 8 octaves. If an organ has only 5 octaves, for various stops the tone generators must be borrowed and only one set, usually the 4-foot set, as it is called, will be complete.

Fig. 3 shows the scale arrangement and the footage notation. This notation is inherited from pipe organs, where the pipes are designated by their length. As you can see, to have a complete set of 16-, 8-, 4- and 2-foot notes, an organ must have 97 tone generators (96 + C). In some organs these are all individual oscillators and, although they are synchronized, each one must be tuned individually. The Conn organ uses this system. But if the divider system is used, only 12 notes, the 12 master oscillators, need be tuned, and the others will follow—provided they remain in step! If not, circuit values in the dividers must be changed, unless they have some adjustable component. The Minshall used to have a habit of getting out of step, and there wasn't any adjustment.

The formant circuits mentioned earlier change the tones from the oscillators to sound like flutes, trumpets, clarinets and all other possible imitations of organ pipes imitating instruments.

On the Hammond a more direct system is used. Mechanically driven (and never detuned) oscillators are connected in such a way that each key can obtain one fundamental and up to seven harmonics of that fundamental, arranged by drawbars. These drawbars are in effect volume controls. The complex tones coming from the formant circuits are amplified in one or more truly high-quality amplifiers with very good low-frequency response. The emphasis is necessary because, to bring out the 16-foot low C, the amplifier and speaker system must be capable of producing 32 cycles per second, without noticeable 60-cycle hum.

If an organ note fails, you can localize the trouble rapidly. If all notes of that designation fail, the master oscillator is probably not functioning. If only some of them fail, the lowest one not working may be the divider which is out of whack. If the notes are fine down to a certain point and then turn sour, a divider is out of step. You can tell more things by just depressing the keys. If the top and lower notes of a chain are OK but one is missing in the middle, you can almost bet that you are discovering key-contact trouble.

When enumerating instruments needed, we mentioned a transconductance checker. As you know from TV practice, a tube which checks OK on emission may refuse to oscillate. Some organ oscillators are sufficiently critical so that tubes which are perfectly usable as amplifiers are no longer usable as oscillators. I have a basket full of 6SN7 and 12AU7's which are no longer any good for organ work.

The amplifiers are nothing unusual, except for their usually high quality,

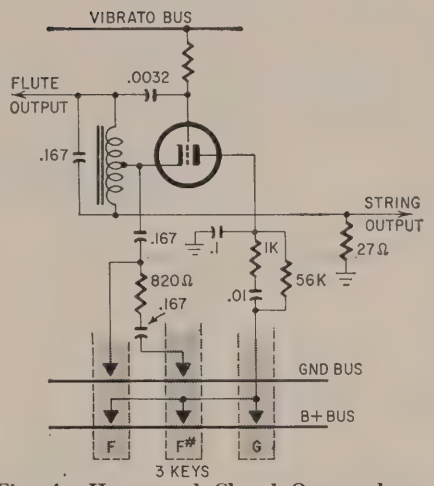


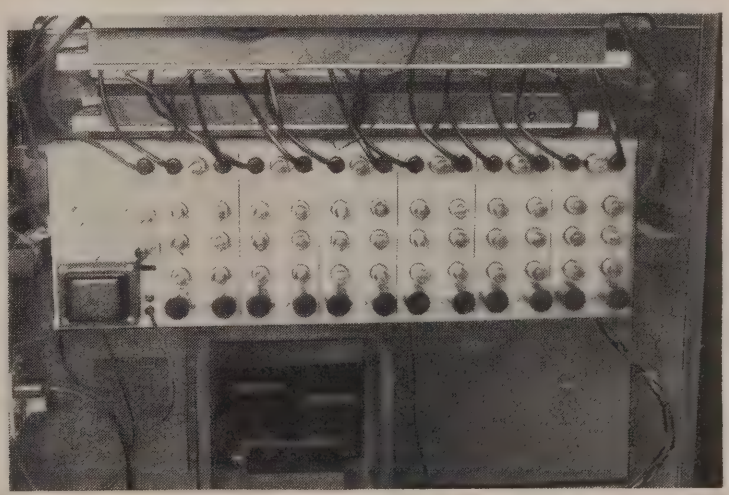
Fig. 4—Hammond Chord Organ three-note oscillator. Each key connects to B-plus, but two insert a network in cathode circuit to change frequency.

and servicing them is like servicing other audio amplifiers.

If a whole stop refuses to work, you are dealing with trouble in the formant circuits or in the tab-switch contacts.

There are many special circuits in organs, but here we can do little more than mention them. In some chord organs, for example, the tones share oscillators. Some tones, usually adjacent ones, are so rarely used together that the oscillators are designed to produce two or three tones each, reducing the number of oscillators tremendously (see Fig. 4).

Organ tuning, electronic as well as pipe organ, is done by starting with one particular note, usually middle C. To tune this note you can use a tuning fork or a well calibrated audio oscillator. How this note is tuned depends on the type of organ you are dealing



Above are the works of the Baldwin A5. Power amplifiers are mounted in the separate speaker cabinets.

(Left) Inside the Hammond Chord Organ the ingenious two- and three-note generators are on the top chassis. Chord generators are at the left, power supply at the bottom. The speakers are mounted in the console and the power amplifiers (two 6V6's) are in about the middle of the upper chassis.

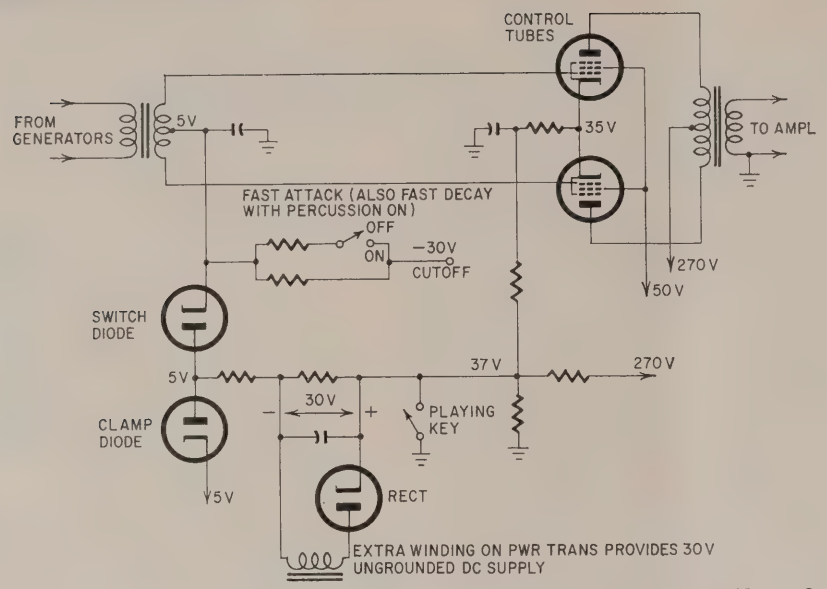


Fig. 5—Simplified solo percussion circuit (percussion on) in Hammond Chord Organ

with. In pipe organs one pipe in each rank would be tuned individually. In an electronic organ, it may be one oscillator all by itself, or it may be the master oscillator of an octave chain.

An organ tone is usually a complex waveform. It contains the fundamental and sometimes many harmonics. But almost *always* a goodly percentage of *second harmonic*, which is twice the frequency and thus one octave away from the fundamental.

If you have an organ with individual oscillators, such as the Conn, you might think of tuning a note by playing it together with one an octave lower and finding a zero beat. But this is not easy because the lower note already contains a large percentage of the upper one, and you will have a hard time discovering when you are actually on zero beat.

Now it happens that other notes are the same as a harmonic of the fundamental, but a harmonic which is not so prominent in the original note. This is the third harmonic. For a C, the note G is the third harmonic. Now in musical terminology this is called a *"fifth" simply because the two notes are five white keys apart.*

In an electronic organ, there is even more reason for using this system, for often all the notes of one kind are synchronized, and changing the master oscillator automatically changes the rest of the chain. Now, however, you tune C with G (its third harmonic), G with D, and so on all around until all notes have been tuned. For you come right back around the circle. The third harmonic of a note must, of course, not show any beats with the fundamental; so you tune for zero beat. There is one exception to this system, and that is B. For *it* the proper key to use is *not* a white key five places away, but a black one, F♯. (This is because of the tempered scale—we do not come out with a whole number when we divide the frequencies of the notes by 12.)

The progression for tuning looks like this: First C, then C + G, then G + D, then D + A, A + E, E + B, B + F♯, F♯ + C♯, C♯ + G♯, G♯ + D♯, D♯ + A♯, A♯ + F, F + C. (If the organ has individual oscillators, this tuning procession must be followed all the way up the keyboard.)

Notice that this way you have actually tuned 12 pairs, but each note of the octave appears once as the fundamental which is used to tune the third harmonic against. Remember (if you are not a musician) that if an organist speaks to you about a fifth or a quint, in terms of frequency this means third harmonic. But don't tell the organist, he will not comprehend and will simply assume that all organ tuners are a strange breed who don't know what they are talking about.

Special things you may encounter might include the modern percussion circuits. Usually these are some form of sharp-cutoff circuit, operated by a rapidly rising bias (see Fig. 5). The rise of bias is controllable, giving the organist various effects to play with. Similarly a plucked effect is obtained by a rapidly decaying bias suddenly turning on the control circuit. A hangover circuit then usually provides a continued tone for a fraction of a second or more after the key is released. The hangover circuit is a feedback circuit which allows the tone to decay only slowly (relatively, that is). Service manuals will be explicit about these special circuits, and usually give an understandable explanation of the function.

Several good books give very detailed explanations of the circuitry of electronic organs. One of them, *The Electronic Musical Instrument Manual* by Allan Douglas, published by Pitman, is the most useful when it comes to studying the various special circuits such as formants, etc. *Electronic Organs* by Robert L. Eby (Van Kampen Press) gives details on the construction of various organs.

How I got into the organ business is simple. I started, with good tools and a good manual, and worked rather long over the first few. I also didn't charge very much. From then on, I gradually became more skilled, charged a little more, spent much less time on the organs, and started to make some profit. This may be the simplest way to get into it. Try it out. Good luck. END

NEXT MONTH

Multi-Impedance Transistor Amplifier

The serious audio worker will find this a very useful piece of apparatus in conducting tests and experiments. A single-transistor amplifier, it matches all impedances likely to be encountered, both in the input and output circuits.

Diagnose TV Faults By Eye

Another of A. V. J. Martin's series of troubleshooting pictures that show actual examples of defects, tell exactly what causes the trouble and how to fix it.

VT Voltmeter or Converter

Using one double-triode tube for both power supply and meter tube, this instrument is a natural for the beginner, experimenter or student. Can be used with any low-range milliameter or your present low-impendance input multimeter, giving it an input impedance of at least 10 megohms.

YOUR HI-FI CABINET

Stop wondering about how you're going to put a professional finish on that unfinished cabinet—just keep reading

By JEFF MARKELL

LET'S assume you've recently acquired a cabinet for your hi-fi gear. It may be a knock-down kit, an unpainted unit from a furniture or department store, or perhaps one you've built yourself. Now the question is, how to get that professional-looking finish that is the final touch on a well-done job. The answer is provided in the paragraphs that follow, which must be combined with some hours of your own time and effort.

Assuming that you're *not* an expert furniture finisher (otherwise you'd have finished the cabinet long ago), let's consider the process a step at a time from start to finish, before beginning the actual work. Then, you can collect the simple supplies and materials needed and begin.

A really good finish requires the liberal use of a secret ingredient—*Work*. This magic ingredient, combined with a modest amount of knowledge and manual skill, will give you a result that is a source of lasting satisfaction. The excellence of your end product will be in direct proportion to the amount of time and effort you expend sanding, rubbing, steelwooling and polishing. So don't waste any of those commodities trying to think of ways to avoid having to apply them. All the possibilities have already been thought up and tried by a lot of other fellows just as clever and just as lazy as you and me.

Now that the dark side of the picture has been given its due, we can afford to mention that some of the curse can be taken off by the proper use of certain power tools, which often can be rented if you don't happen to own them.

Probably the most important single factor in producing a good final finish on a piece of furniture is the manner in which the surface is prepared, before any lacquer, paint or varnish is applied. It's just not possible for the finish to be any better than the surface underneath it.

Let's assume now that your cabinet is completely assembled, with all the required parts present and in place. For speaker cabinets, this means the baffle board and back have been fitted, speaker hole cut, and any ports or horn sections cut and fitted. In an equipment cabinet, doors, drawers, lids, drop fronts, slides, hinges, catches and lid supports are all fitted in place and are working properly.

Take a look at it—isn't it pretty? Fine! Now tear it all apart!

Everything that can possibly be removed comes off. That means doors, drawers, lids, baffles, backs, control panels and all associated hardware—in short, anything that is not glued down to stay.

Ready to start sanding

When everything is stripped off, you are ready to start sanding first the main case, then the various other parts.

If you have handled your materials reasonably carefully when you built the cabinet, the chances are you will not find any bad scratches or gouges in the surfaces. But you *will* find a batch of minor scratches. These are pretty inevitable, but must be removed.

Use a relatively fine sandpaper from the very beginning—no coarser than No. 0 garnet paper. Your fine-surface veneers are not very thick, and it will not take much sanding to go clear through. All you want to get off are the scratches, not the veneer. Harder woods like oak will stand slightly coarser papers than, say, mahogany or walnut.

Always sand in the same direction as the grain—never across the grain, and wrap your sandpaper around a flat sanding block when doing the large flat areas.

If you have an acceptable sanding machine available, it must be the type that has a flat head on which a piece of ordinary sandpaper is mounted or be a belt sander. The flat-head types usually have an orbital motion. They are OK for preliminary sanding, but should be followed by hand sanding with the finest possible paper, preferably about No. 4/0. A belt sander can be used for both preliminary and final sanding, provided you obtain a belt with a fine enough grit for the final sanding. Even then, some areas cannot be reached with the belt. These have to be done by hand. And, of course, curved parts like moldings, turnings and beadings are out for the machine. And by the way, *don't put a sanding disk on your electric drill and try to use it for sanding furniture. If you do, the result will be appalling.*

Don't forget that your final sanding should be with the finest paper you can get. In any event not coarser than 2/0, preferably 4/0. The finer this last sanding is, the easier it is to get a really good finish. And be sure you get places like the edges and backs of doors, the undersides of lids, the insides of player wells and the insides of record storage compartments. Anything that can be seen at any time is important.

When you think you are through sanding, inspect both visually and by touch. Sometimes you can feel rough spots that you cannot see until after the finish has been applied. But then, it is too late. After you are satisfied that you've done a really good sanding job, clean away all sanding dust and get ready to start applying the finish.

The first step is either staining or bleaching. You stain when you want to darken the color of the natural wood; you bleach when you want to lighten it. If you want to leave the natural color of the wood alone, skip both operations and begin with filling. For the benefit of those who want to precolor their wood, these operations are discussed first since they must be done first.

Using a stain

A stain is a type of dye and must be mixed with a liquid vehicle before it can be used for our purposes. There are three types in common use: water, oil and alcohol stains. Each has certain advantages and disadvantages.

Water stain is the one most commonly used. It penetrates well in most woods, is easy to prepare and use, goes on with good uniformity and is not excessively slow drying. There is one trouble with water stain—it tends to raise the grain of the wood a little, usually making it necessary to sand the piece lightly after staining to remove the "peach fuzz."

Oil stain does not have this fault. It does not raise the grain, but neither does it penetrate as well as water stain. Its penetration is particularly poor on dense, course-pored woods such as oak, but it is all right on softer, closer-pored woods such as mahogany. Oil stain takes longer to dry than water stain,

but it eliminates the defuzzing needed after water staining.

In the highly resistant woods—dense coarse-pored wood like oak or with a high oil content like teak an alcohol stain is the best bet. It has the highest penetrating power of all and is the fastest drying. Because of this rapid drying, alcohol stain is more difficult to apply uniformly, but with a little practice this problem can be mastered.

In staining, the first thing is to decide what color you want. Since a wide variety of prepared stains are available, the chances are that you will be able to find a satisfactory color without too much trouble.

A specific stain has a different effect on each type of wood to which you apply it. This is caused partly by the differences in the colors of the woods before staining, and partly by differences in the densities and pore structures of the woods, which in turn affect the penetration of the stain.

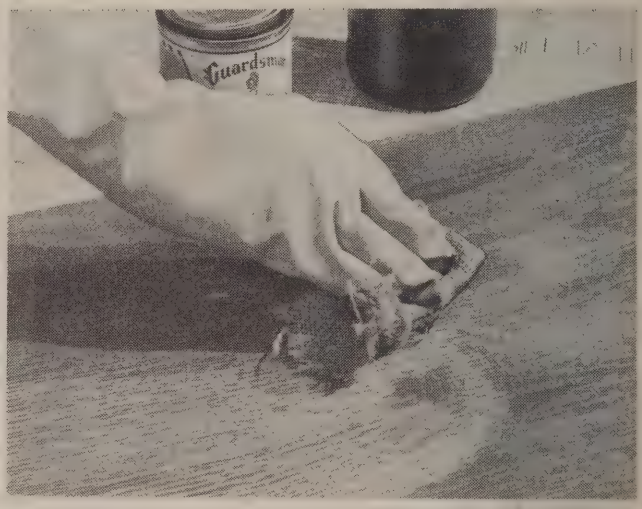
This now leaves you with the problem of finding out how stain X will affect your particular kind of wood. Simply apply some of the stain to scraps left over from the material you used to make your cabinet, and see what the result is. If it comes out too dark after it dries, thin out the stain and try again. If it is too light, go back and get a darker stain.

Remember one other thing, however, in finalizing the color of your stain. A piece of wood that has been stained appears only a shade lighter than one that has been stained and lacquered. So if you are in any doubt, put some lacquer, shellac or varnish on a stained sample, and see what you get. This is the only way you can really see your final color in advance. As soon as you've settled on the color, the hardest part is done. The actual staining is easy.

With water or alcohol stains, just slap 'em on and let 'em dry. But be sure you give them enough drying time before you move on to filling. Water stain can be deceptive, particularly in humid weather when it may feel dry even though it isn't. Under such conditions play safe and give it a little extra drying time.

Oil staining is different, but still very simple. Your oil stain will be a fairly thick, gooey mixture. Brush it on, wait 5 or 10 minutes, and then wipe off the excess with a rag, cotton waste or a pad of dime-store cheesecloth. The length of time you let an oil stain stand to penetrate has an effect on how dark the stain will be, so do not work too large an area at one time, and try to keep the standing time equal on the various parts. An oil stain takes longer to dry (at least overnight), than either of the other two types, so be sure to take this into account before moving on to filling.

Apply filler generously to wood, using a circular motion.



Pad the filler into pores by wiping across the grain with burlap or other coarse cloth.

Want to bleach it?

Before telling you how to bleach I ought to state flatly that it is something *I* would avoid wherever possible. Bleaching is usually done to mahogany to get a blond finish, but it seems that, with all the excellent blond woods now available, you should be able to find a naturally blond wood to use, making bleaching unnecessary. Bleaching does not necessarily result in a uniform color even when done correctly, and the process does not guarantee stable results, since dark streaks may appear in a finish that originally did bleach evenly.

Most bleaches consist of two compounds, applied to the wood one after the other. They are standard mixtures, available from finishing supply houses. The most common bleaching procedure goes like this: You apply the first mixture, let it stand for 15 or 20 minutes, and then apply the second. After that let the whole thing dry thoroughly. At the end of the first stage, the piece will have lightened partially but you do not see the full effect until after the second mixture dries.

After a piece has been bleached (the second mixture has dried), it must be thoroughly washed down to remove excess bleaching chemicals. Do this with a dilute solution of oxalic acid, acetic acid, or a dilute solution of vinegar (about 1 quart of white vinegar to 1 gallon of water. After the washdown, the piece must be thoroughly dried. It may even need another light sanding.

Filling

If you have not done any precoloring, the finishing process starts here. If you have, this is the second step. For filling, use a paste wood filler, mixed as directed to a creamy consistency.

If you're wondering what filling fills, it is the little tiny pores in the surface of the wood. If unfilled, they show up in the final finish as innumerable little pocks that are practically impossible to eradicate. Filling is easier! There are a few very fine-pored woods that do not need filling—birch, maple, gum or beech—but walnut and mahogany need a good filler. So do oak, limba, primavera and most of the other woods you are likely to use.

Filler comes in various colors, so naturally you use the color that most nearly matches your wood. The filler when mixed is a fairly thick goo. Brush it on, let it set for a few minutes, and then wipe away the excess with clean rags, waste or cheesecloth. Wipe *across* the grain to drive the filler into the pores. This is the *only* time in finishing when you wipe or rub across the grain. After excess filler has been

When applying finish, start new stroke on dry wood and brush toward the previous stroke.

Sand-finish the surface lightly. Just enough to dull the sheen without cutting through the finish.

Photos Grand Rapids Varnish Corp.

wiped away, the piece should dry for a minimum of 6 hours or, better yet, overnight. If the filler is not dry enough, it pulls out of the pores when you start to apply the finish on top of it.

Sealing

Your sealer is really the first coat of the final finish. The only difference is that the sealer is going on over raw wood and tends to be absorbed a good deal more than later coats. Therefore, the sealer coat is about 50% thicker than what you will use afterward.

Under a lacquer finish use a lacquer sealer. Under varnish or shellac finishes, use shellac. After the sealer has thoroughly dried, give it a light sanding with the finest possible paper before proceeding to the final finish.

Final finish coats

In commercial finishing, the material used for final finishing is either natural or synthetic lacquer applied with a spray gun. Varnish is much too slow in drying for commercial work, and shellac, although rapid-drying, is comparatively soft and leaves much to be desired in the matter of durability.

Where possible, lacquer is the material for the home craftsman. It combines the advantages of varnish and shellac, without the disadvantages of either. It has the durability of varnish combined with the rapid-drying properties of shellac and, being a water-clear liquid, it has less effect on color than either one.

If you have spray equipment, practice with the gun on scraps to get used to it before starting on the cabinet. The two most common defects in amateur spraying, and for that matter even in professional spraying, are "orange peel" and "runs." Orange peel is a rough surface texture caused by inadequate atomizing of the laquer in the gun, or by holding the gun too far from the work. Runs are caused by spraying too much lacquer on one area. The excess material forms driblets that run down from the over-sprayed area. These are unsightly and difficult to remove.

Another problem that sometimes arises in spraying is called blushing. It is characterized by semi-opaque milky areas on the surface and is generally caused by excessive humidity. If this happens, quit spraying and wait for a drier day.

If you do not have spraying facilities, apply the lacquer with a brush. You'll never get it on quite as smoothly with a brush, but a bit more rubbing will make up for the difference. Work rapidly because the lacquer dries quickly, and no not brush repeatedly over the same area, or you'll get laps and streaks. When applying one coat over another, it is even more important to work fast lest the solvent in the second coat soften the first. This really makes a mess. Again, as with spraying, a bit of practice makes a world of difference. Stay away from pressure cans of lacquer for your finish coats—the lacquer is too thin for anything but touch-up work.

If you want to shy away from lacquer, or if it sounds a bit too tricky for your first try, use varnish. It is much slower drying so you have more working time, but also remember to give it plenty of drying time between coats, and you will end up with an excellent finish.

If for some reason you use shellac, OK. But remember you do not get the durability of lacquer or varnish. Don't let water or alcoholic beverages stand on a shellac finish. Water turns shellac an opaque white, while alcohol just plain eats it away. After all, the solvent for shellac is denatured alcohol.

In furniture finishing, a lot of thin coats are always better than one or two thick ones. They go on more smoothly, dry better and need less rubbing. Usually, three coats are enough to build up a finish, but you might conceivably have a condition that requires more. When in doubt, put on another coat. It cannot do harm and it may help.

Rub a finish

If all you want is a plain gloss finish, you can stop after building up the coat to final thickness, and eliminate the rubbing. You can even use a flat lacquer or varnish for your last coat and get a flat finish without rubbing. Either one is often adequate for large built-in wall installations but, for free-standing furniture to really look right, it should be rubbed.

Many people prefer a matte or satin finish, others like a high gloss. For either, the first step is the same. This consists of thoroughly rubbing all surfaces with a wet–dry paper dipped in a solution of soap and water to keep the paper from clogging. Minnesota Mining No. 400 A or equivalent is ideal. Your purpose is to remove all minor irregularities left by the brush or spray. This method is for lacquer and varnish finishes only. Do *not* use water on a shellac finish. Use ground pumice and oil. You can also use pumice and either oil or water on lacquer and varnish if you'd rather. If you have trouble finding wet–dry abrasive paper, forget it and use pumice.

After the first rubbing, the final step depends on whether you want a satin finish or a high gloss. For a satin finish, go over everything with an extremely fine steel wool. Don't take your wife's pot scouring wool from the

kitchen. *It is not fine enough.* Try to find some 4/0.

For a high gloss, get some furniture rubbing compound and rub until the gloss suits you. If you have trouble finding the compound, it may be easier to locate some rottenstone. If so, use that. Your local paint store, and some hardware stores, can give you a lot of help in locating materials.

Touchup where needed

Since this article deals with new work I shall mention touching up rather briefly and leave a more detailed discussion of this subject to a subsequent article which will deal with touchup, repair, and refinishing of old work.

In any event if you have done a reasonably careful job of finishing and rubbing, the defects that you are likely to find are minor. If you do find any defects worthy of attention, they will probably be one of two kinds. You may find that here and there along a corner or edge you have rubbed clean through the finish. This is not uncommon and shows up most on dark finishes as a light line along the edge that has been rubbed through. This light line is removed by touching it up with a bit of your original stain, and then a bit of lacquer applied with a fine artist's brush.

The other defect you might find is a dent here or there that was in the wood before you did any finishing at all, and for some reason was not previously removed. These can often be filled by a procedure called "burning in." To do this you need a shellac stick of the appropriate color for your finish. A small springy artist's palette knife, and an alcohol lamp. Heat the knife over the lamp, and touch it to the shellac stick. The heated knife will melt a bit of shellac and pick it up. Use this material while soft to fill the dent. It hardens as it cools, so work quickly. Knife it in as evenly as possible, then smooth off with very fine sandpaper, and polish.

Reassembly

Your finish is now complete but before you apply a final polish and put the piece to use, you have to reassemble all the parts you removed. With speaker enclosures this may mean merely a baffle and a back, but equipment cabinets usually involve doors, drawers, lids, control panels and who knows what hardware. Work slowly and carefully so you are sure you are getting everything back exactly as it was. You do not want to drop or mar any parts, now that they are finished!

After it's all back together, it's a good idea to give the whole thing a coat of hard wax as a protective measure before putting it into use. Do not use one of the self-polishing liquids. They do not have enough body. They are all right for later on but, for your first waxing, use a good heavy hard wax as protection.

Oil finish

No discussion of finishing is complete without a mention of the oil finish that has become so popular, particularly in recent years on walnut. This type of finish results in an extremely matte surface that emphasizes the grain and figure in the wood and is particularly beautiful on well figured woods.

There are two ways of handling an oil finish. It is applied either direct to the raw wood or over a filler. Where a filler is used, the procedure for filling is the same as previously described. I personally prefer an oil finish on the raw wood, but it is strictly a matter of taste. Of course, presanding is needed in this process.

The oil used for an oil finish is linseed and is applied hot to improve its penetration. Apply hot linseed oil, let the piece stand for about 20 minutes, wipe off the excess oil and let the piece dry overnight. This procedure should be repeated from three to six times. An oil finish should be reoiled about once a month for the first few months and then once in 6 months.

Oil finishes are a bit darker than lacquer finishes to begin with, and darken somewhat with time. So do not expect a newly oiled piece to quite match an old oiled one or a lacquered one, even though they are all made from the same kind of wood. END

I Like Audio Work

By JOHN A. COMSTOCK

IT was 9 am and my shop was open for business, as usual. The phones were quiet and no one was in the store. That was my chance to get at some of those piled-up items on the bench. The first was a Spartan-Collaro record changer. The motor on the unit was really making a racket. With the motor running, I started tapping it (the motor) on all sides with a screwdriver handle. Within a few minutes, the racket was gone and normal quiet operation resumed. This works for many of these units as motor bearings are self-aligning and usually seat when the motor is tapped.

Some free information

Buzzzzz, from the front door as it opened (translates into "someone in the store")—and away from the bench to the counter to greet my first customer of the day. He wanted a new head for his tape recorder—would install it himself. Also wanted some information. He couldn't understand why his old head showed wear so soon. A few questions revealed that the tape was run over the head all the time, even when rewinding. I suggested that he reroute the tape around the head when rewinding and showed him how. I explained to him that by rerouting the tape you keep the head clean and give it a longer useful life. I also told him that every time the abrasivelike oxide-coated tape passes through the head, it grinds away minute particles of metal, which eventually results in impaired sound reproduction.

Printed-circuit capacitor

The next job was an amplifier that used a printed-circuit board. It just wouldn't work. A few circuit checks revealed an open coupling capacitor. Now all I had to do was replace the unit. But it was a single-ended job, and I didn't have one of the proper value in the shop. A few minutes time and I came up with an answer. I took a standard capacitor (the right voltage and capacitance values, of course) and bent one of its leads over and down the outside of the capacitor's body. Next I slipped a piece of spaghetti over the unit. It wasn't tight enough, but a couple of drops of service cement kept it in place. Then all I had to do was solder it into the circuit.

Protect speaker cones

The phone rang. "This is Mrs. Foster. When are you going to deliver my amplifier? You promised today."

"I was just leaving for your house now." And I was, as soon as I put the phone down. I grabbed the chassis and reached for the speaker, but stopped when I remembered how the last time I had one of these jobs I punctured the speaker cone. To keep that from happening again I put the speaker, face down, into a paper bag and rolled up the top to give me an easy to grab handle. Then I grabbed the bag, shoved the amplifier under my arm and was off on the job.

Record static

After installing the unit and showing the customer that everything was working properly, I was told that after a record was played several times it would start causing hissing, snapping and crackling noises. I asked him to show me, and he did. Close examination of the disc revealed the trouble—grit and dust in the record grooves. Nothing wrong with the player at all! As I always do when this question comes up, I simply told her to wash her records with a sponge dipped in cool water to which a capful of mild liquid detergent has been added. Then rinse and let the discs air-dry. Never did get a complaint of that type from her again, and she always calls me for any electronic repair in her home. END

ALL ABOUT THE REFLEX ENCLOSURE

Part VI —*Damping can reduce irregularities in a speaker system's response curve. This is how it works*

By P. G. A. H. VOIGT

ARTIFICIAL damping takes up sound energy. This seems ridiculous since a speaker is supposed to produce energy. However, few systems are uniformly efficient over the audio-frequency scale and artificial damping has the advantage that sometimes it can be used selectively. Selective damping is damping which is particularly effective in a certain frequency range or which affects one particular mode of vibration. Thus it makes possible individual control of specific resonances or selected parts of the scale.

Assuming that the cabinet is well built, the frequencies to watch are:

- The region near the upper peak in the impedance curve.
- The region near the lower peak.
- The region of maximum coil current in the trough between the peaks.
- Any peaks caused by internal stationary waves and reflections.

Normal damping materials apply frictional losses to the sound waves to turn the sound energy into inaudible heat energy. There are two main ways in which these materials operate, and both can be used in the same cabinet simultaneously.

When an ornamental grille cloth is placed across the front of a speaker, the sound has to pass through the cloth. As the air particles move through, there is some sound energy loss because of friction, and additional friction loss as air particles penetrate into and emerge from the thread itself.

The first kind of motion reminds me of the way water passes through a fishing net. The frictional loss depends on the relative velocity of the air through the obstacle, and ceases if there is no relative motion. The motion when the second kind of loss takes place reminds me of the way water penetrates a sponge. A difference of air pressure between the air outside the thread and that within its fibers is required to produce the air penetration.

When a stationary wave occurs in a cabinet, regions with maximum pressure variation and negligible velocity are set up. Other regions, usually spaced a quarter-wavelength away, where the velocity is maximum but pressure negligible, are also set up. **Maximum pressure or maximum velocity, thus determines which kind of frictional absorption can be used advantageously.**

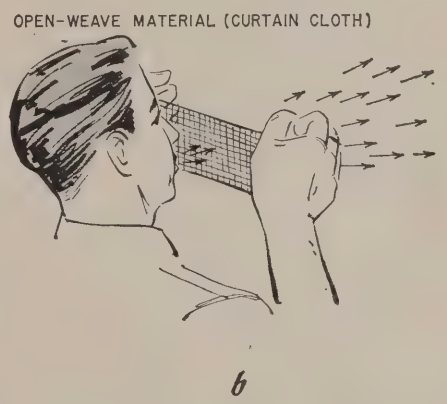
Sound-absorbing materials

Carpets, felt and similar densely packed materials are often used to line the inside walls of cabinets and thus act as sound energy absorbers in the high-pressure regions. However, some of these materials may cause unexpected trouble later.

Moths have an uncanny knack of finding wool anywhere in hi-fi equipment and after a while they spread to clothes, carpets and other things of value. Damping materials liable to draw moths should therefore be avoided.

Fiberglas is stocked by some hardware dealers and is used for thermal insulation. It is often recommended and moths find it rather indigestible. (Handle Fiberglas with care. Wear a pair of leather gloves if possible.)

Fig. VI–1—With two small pieces of cloth you can demonstrate the effect of different fabrics that might be used for damping: a—cotton handkerchief; b—piece of window curtain.



One way to increase the effectiveness of many absorbing materials is to fix them with folds or corrugations set to form air pockets. This way more air has to penetrate and merge during each sound wave.

Since frictional loss occurs every half-cycle, high frequencies are affected more than low ones. For example, while a layer of thick carpet may absorb most of a 3,000-cycle wave which strikes it, absorption at 30 cycles is negligible.

So lining the walls is not much good when you want to damp low frequencies and the technique mentioned first (reminiscent of the fishnet) is preferable. The damping material is placed so the sound waves pass through it. The dense materials previously discussed are unsuitable for this. They might stop the flow almost completely, dividing the enclosure into separate compartments. Materials for absorbing sound energy as the sound passes through them have a much more open texture.

Stretch a single layer of cotton handkerchief across your mouth and blow (see Fig. VI –1-a). The resist-

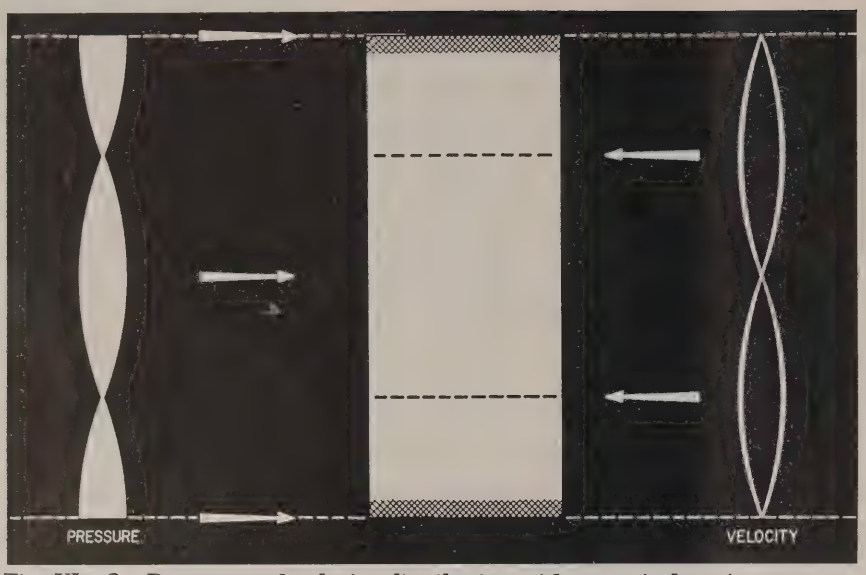


Fig. VI –2—Pressure and velocity distribution with a vertical stationary wave of two half-wavelengths.

ance can be felt easily. Now try again with a piece of window curtain. You will notice a great difference. Closely woven textiles are even more resistant than the handkerchief. Each causes some energy loss when air passes through it, but the more closely woven the material, the greater the resistance. Thus, the desired amount of damping can be obtained by selecting a suitable material. There is plenty of scope for experiment.[1]

Materials that are intended to act on sound as it flows through them have to be positioned (conveniently on frames) across the sound path. If vertical, these materials should be stretched, if they hang limp they may move *with* the sound, reducing the relative velocity and, in turn, the amount of damping. Materials which act as damping agents when sound flows through them are usually too light to act as absorbers in the pressure regions. A layer of handkerchief has a negligible effect, when compared with a 1-inch layer of Fiberglas, for lining the pressure regions along the walls of a cabinet. Thus, the two kinds of sound absorption require quite distinct techniques, and this permits a useful amount of juggling.

How to apply damping

Suppose we have a box baffle and want to absorb the vertical stationary wave corresponding to one complete wavelength. The box is shown in Fig. VI –2. The vertical sine wave at the left of the box shows the *pressure* distribution, and the three arrows on the left point to the maximum-pressure regions. Densely woven thick materials at those three levels would absorb some of the pressure energy but, if placed at all three levels, the cabinet would, in effect, be divided into two parts by the middle layer. (This may or may not be desirable but does not concern us now.) Omitting the middle layer avoids complications. At the top and bottom levels, complete layers can be used safely without dividing the box. The end layers are shown in the diagram as shaded regions.

The curve at the right of the box shows the velocity distribution of the vertical stationary wave and the arrows on the right point at the two maximum velocity levels. Inside the cabinet the levels are shown as dashed lines. Flow type absorption will be most effective if suitable materials are placed at those (dashed) levels. Burlap (sackcloth) is inexpensive and quite suitable. A layer of such material attached to a frame could be used at either or both of these levels.

Thus, in practice, we can absorb energy from that particular stationary wave at four levels. (At the two intermediate levels where there is maximum relative velocity, by flow friction, and at the highest and lowest levels where the pressure peaks, by penetration friction.) With appropriate materials, energy can be absorbed at all four levels simultaneously.

Another vertical stationary wave, but of half the previous wavelength, would form pressure nodes at the levels of the dashed lines where we had maximum flow. So that wave would not be affected very much by any light material just there. At the top and bottom, however, the thick layers would absorb and, since at half the wavelength we have double the frequency, they would absorb more effectively than at the lower wavelength.

As lateral stationary waves do not flow through the horizontal intermediate layers, they are not affected appreciably by these. Layers stretched parallel with the sides would serve. If the cabinet proportions are approximately those discussed in the article on box baffles (32 x 20 x 12½ inches) (see "A Box For Your Speaker," RADIO-ELECTRONICS, January, 1959), the lateral stationary waves will be of higher frequency than the vertical ones. So damping by lining the side walls should be effective and make other complications unnecessary.

Absorbent wall lining does little to affect the basic Q of the air cushion or speaker because of the low effectiveness of such a lining at the very low frequencies concerned. Other means should be used to cut down the Q at the frequencies of the two main impedance peaks when the highest possible efficiency there is not required. Damping the lower peak frequency diminishes the likelihood of speaker overrun at just that very low frequency where this is most likely to occur. Damping down the upper peak frequency diminishes one cause of boomy bass, and is particularly important if that frequency is in the speech boom region.

Anything that impedes the free flow of air at the port also acts as a damping agent and can be used to reduce the Q of the air system. Used at the port, it affects the series resonance (lower peak) directly at the region of maximum flow while the parallel resonance is affected to a lesser extent. One or more layers of burlap (sackcloth) across the port will do quite well.

Special damping systems

Much ingenuity has been expended in producing special arrangements. For example, Goodmans industries of Britain, who have made a study of the problem, have produced an "Acoustic Resistance Unit"[2] arranged to fit into the port. This contains damping material well supported within a rectangular wood frame whose dimensions have been worked out very carefully. The question of support is important, for, if the damping material "flaps about" with the sound wave, the air won't flow through the material in the way intended and the proper frictional absorption of energy will not take place.

Damping at the speaker opening is also possible. If it is covered with suitable damping material, a useful reduction in speaker Q can be obtained easily. The results could, however, be disas-

[1]D. E. L. Shorter in *Wireless World* (November and December, 1950) describes the method used by the BBC.

[2]E. J. Jordan, *Wireless World*, January and February, 1956.

Fig. VI –3—Damping material over rear of speaker damps parallel resonance without affecting direct highs.

trous, as even one layer of some grille cloths can cut down the high frequencies from the speaker. The loss with enough layers to affect the low frequency of the parallel resonance (upper peak) might well be fantastic.

By putting the damping material behind the speaker instead, the direct highs are not affected, but the parallel resonance is damped just as effectively. A simple way is to stick one or more layers of closely woven textile onto the speaker basket so as to cover the openings. Another way is to cover the back. The photo (Fig. VI –3) shows how I did this during an experiment.[3] The textile was fixed at its edge by tacking it to the wood surface around the speaker and in the middle by a wire bound around the magnet.

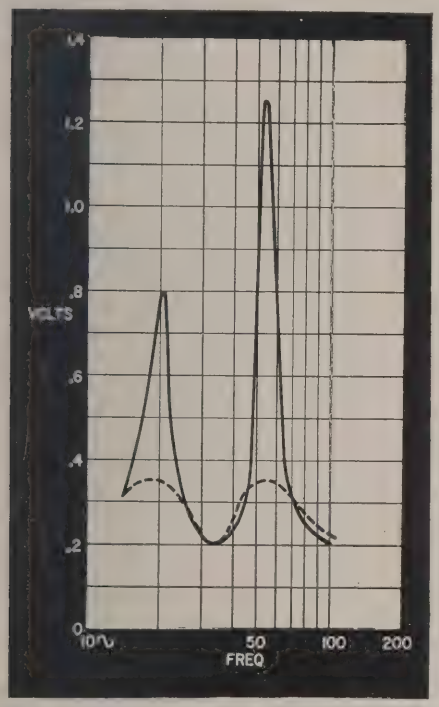


Fig. VI –4—The effect of damping on the two impedance peaks of reflex enclosures.

The solid line in Fig. VI –4 shows the impedance curve for a 6.4-cubic-foot cabinet (without any textile damping) in conjunction with a 10-inch speaker having a free air resonance at 35 cycles. Fitting four layers of textile across the back of the speaker as shown in the photo brought the impedance peaks down to the level shown by the dashed line in Fig. VI –4. There was no special damping at the port nor was there any internal damping while these curves were being taken. As you can see, **both the series and the parallel peak are reduced very effectively.**

Next month we will discuss variable electromagnetic damping and how putting the enclosure in a corner of a room affects results. TO BE CONTINUED

[3]I am indebted to Mr. O. C. Schwartz trading as Americal Radio & T.V. Supply Co. of Toronto, for the use of lab facilities to obtain the experimental results shown in Fig. VI–4 and the photo of Fig. VI–3.

new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

STEREO has stimulated a reappraisal of microphone placement at recording sessions. The trend is toward closer miking. The distance formerly required between microphone and performer in monophonic work for realistic illusion of space can be reduced in stereo recording and still provide a more spacious aural environment. A close mike placement has always offered practical advantages. Is there an older trick in the business than a lower volume setting at the recording console to hold down tube noise and distortion all along the line? In the hall itself, direct waves of sound still have more musical meaning to a recording microphone than do their reflected relatives bouncing off the walls. Several records reviewed this month put these factors to good use.

RACHMANINOFF: *Piano Concerto No. 3*
Van Cliburn, Pianist
Kiril Kondrashin conducting Symphony of the Air
RCA Victor Stereo Record LSC-2355

Taped May 19, 1958, during the course of a Carnegie Hall performance, this recording preserves an interesting moment in the career of the music world's current phenomenon, Van Cliburn. It offers the historian an early sequence in the trajectory of a blazing comet in the concert field. The trail of the Cliburn legend on records is still nebulous. We may in time witness a second Cliburn release of this particular concerto in an interpretation of greater maturity and poise. The proximity of the stereo miking is ideal for the small-scaled concept of the work set forth by the pianist and orchestra. The wide dynamic range offers maximum realism at average volume on a playback system that has an exceptionally low percentage of hum.

TCHAIKOVSKY: *Ballet Suites (Swan Lake, Sleeping Beauty)*
Arthur Winograd conducting Virtuoso Symphony of London
Audio Fidelity Stereo Record FCS-50,010

You can't go wrong in this pair of ballet scores. The performances have a professional sheen and the engineering is meticulous in every detail. Exceptionally wide-range response merits expensive amplification. This record has low-end energy found in very few stereo discs available today. It may prove to be excessive in the case of bass reflex enclosures of insufficient thickness and bracing. Bass response is smooth and flawless on systems free of peaks down to 50 cycles per second. Winograd doesn't fuss with the music and the British musicians, particularly the wind players, turn in a fine performance. Sounds like multiple miking at close range.

PUCCINI: *Madama Butterfly*
Tullio Serafin conducting Chorus and Orchestra of Accademia di Santa Cecilia, Rome
London Stereo Records (4) OSA-1406

No record collection may be considered complete without this most melodious of operas. The better your equipment, the more emphatic will be your preference for the sound of the latest London version starring Renata Tebaldi. This album offers powerful evidence in favor of close miking technique. Puccini's music flows at a more comfortable volume than that of Verdi or Wagner. Accordingly, London's engineers were able to work soloists at distances as close as 10 feet. With proper acoustics, the vital element of space is maintained at that distance even during the scenes featuring the full vocal ensemble.

BEETHOVEN: *Symphony No. 9 "Choral"*
Otto Klemperer conducting soloists, chorus and Philharmonia Orchestra
Angel Stereo Records (2) S-3577

None of the complaints voiced in last month's review of Decca's stereo Beethoven *Ninth* apply to the Klemperer version now available in stereo. The first movement occupies all of side one and the second and third movements share side two, thereby avoiding the complications fostered by crowding in the Decca version. The other points of importance, the recorded level and signal-to-noise ratio, no longer present the problems Angel has known in the past. Having waited this long before releasing this important performance of Beethoven's *Ninth*, Angel is now able to offer a towering work in competitive sound. A more detailed analysis leading to a final choice among existing stereo versions will have to wait until Columbia issues its new Bruno Walter performance of the *Ninth*. At the moment, Angel has the lead.

Rashomon
Laurence Rosenthal conducting instrumental ensemble
Carlton Stereo Record STLPX 5000

Looking for a stereo record that is different? Try this music from the Broadway play *Rashomon* which deals with the Japan of a thousand years ago. In composing the original score, Laurence Rosenthal drew upon a wide variety of Oriental music although the instruments used are found at many points of the globe. New and different stereo vistas are created with imaginative use of the samisen (a three-string Japanese instrument), Balinese and Burmese gongs, Indian ankle-bells, Chinese wood-block drum and other exotic instruments from Tibet, Nigeria, Turkey and South America. Out of this

percussive Tower of Babel emerges a fresh evocation of ancient Japan. The sound is superlatively clean and the vivid use of stereo affords terrific opportunity to demonstrate the new medium.

***Porgy and Bess* (Original Sound Track Recording)**
Columbia Stereo Disc OS-2016

Samuel Goldwyn's motion-picture version of Gershwin's moving folk opera has caused enormous activity within the record industry. With the release of the movie's sound track, Columbia has two stacks of blue chips in its corner, the complete opera issued 7 years ago and the score as heard in the film. The 12 sound tracks of the movie version were mixed to form the two channels heard in this release. The typical Hollywood equalization in the sound track introduces a problem that is not new. The peak in the mid-frequencies causes sibilance in some of the songs, not the tractable sibilance heard on any wide-range sound system but an out-of-control peak where Columbia's curve meets that of Hollywood head on. The stereo has a depth beyond the average. It is used with skill and imagination in the sequence depicting a morning in Catfish Row. Although this album enjoys the advantages of stereo, it does not displace the complete three-record opera set (Columbia OSL-162).

ELGAR: *Enigma Variations*
VAUGHN WILLIAMS: *Fantasia on a Theme by Thomas Tallis*
William Steinberg conducting Pittsburgh Symphony Orchestra
Capitol Stereo Record SP-8383

Those who prefer a softer and more spacious stereo sound will find these two British works to their liking. During some of the variations depicting various friends of Elgar, the music sinks to a whisper in the strings. In spite of the greater-than-average distance traveled by the sound, a hum-free system maintains contact with the composer's ideas at levels below those of comparable mono recordings. The Vaughn Williams *Fantasia* illustrates very effectively the interplay of the two string orchestras specified by the composer.

MOZART: *Sinfonia Concertante*
HAYDN: *Sinfonia Concertante*
Eugene Ormandy conducting Philadelphia Orchestra
Columbia Stereo Record MS-6061

This record will hearten veteran collectors who recall with affection the high points of the Philadelphia Orchestra's career on records. The first-chair players of the orchestra are offered here an opportunity to display their skill in music worthy of their talents. Oboe, clarinet, bassoon, horn, violin and cello occupy prominent positions in these two compositions, which combine the appeal of concerto and symphony. The music is delicious and the tonal range lies easily within the capabilities of today's stereo cutter. The result is a disc commendable from any standpoint.

BEETHOVEN: *Symphony No. 2*
Eugen Jochum conducting Berlin Philharmonic Orchestra
Deutsche Grammophon Stereo Record DGS-712006

Performances recorded in Europe by this leading German firm are now available in this country under the familiar yellow and blue label at domestic prices. Formerly imported from Germany for the benefit of collectors willing to pay the price, Deutsche Grammophon discs are now being pressed and distributed in America by Decca Records. Decca, for some time, has been issuing Deutsche Grammophon performances in this country under its own label. This new arrangement will make available to American discophiles a wider selection of German recordings. These always have been interesting products from the standpoint of performance and engineering. Beethoven, at any point in his career, is second nature to the men of the Berlin Philharmonic heard here. Jochum leads a performance of ease and grace. Very low noise levels permit miking that is far more distant than ours. The recording curve is flatter than nine-tenths of those now in use. Stereo definition and separation in this particular disc were better with the phasing switch in a reverse position.

MENDELSSOHN: *Italian Symphony*
TCHAIKOVSKY: *Capriccio Italien*
Edouard Van Remoortel conducting Orchester Der Wiener Musikgesellschaft
StereoVox STPL 511.210

Vox displays refreshing candor in setting up a special price of $2.98 for one of its regular releases. This item, one of the first in its new Thriftmaster series, is to all intent and purpose a normal $5.95 stereo release with one of their better conductors leading a middle-grade European orchestra. The only difference I could detect between this and full-price Vox discs arriving in the same shipment was one of hall acoustics. Remoortel does not enjoy the full-bodied sound heard in a companion release wherein Jonel Perlea leads the Bamberg Symphony Orchestra in an ingratiating performance of the Dvorak *Fourth Symphony*. I've heard more exciting readings of Tchaikovsky's *Capriccio Italien* than Remoortel manages here but the Mendelssohn is a good buy at this price. Plenty of ebullience in the stereo.

Holiday in Brazil
Bud Shank, alto sax, and Laurindo Almeida, guitar
World Pacific Stereo Record 1018

World Pacific was one of the first record companies to solve the early problems of the stereo disc. From master tape to finished pressing, their audio quality has been consistently first-rate. This is demonstrated in these subtle Latin compositions and arrangements by guitarist Laurindo Almeida. In addition to the fluent alto sax of Bud Shank, *Holiday in Brazil* offers crisply miked drum and tabla stylings by Chuch Flores. Much of the charm of the unusual instrumental combination would have been lost in mono recording.

The Wild Wild West
Ralph Hunter Choir
RCA Victor Stereo Record LSP-1968

Once you've driven this group of voices through two Ultra-Linear channels, you won't want to go back to the artificial city ways of most records. Don't take my rave for it. Trade in your last pouch of gold dust for this disc and audition it at the fanciest audio saloon in town. The presence is fabulous. Listen for the intake of breath at the end of the stanzas. The ranks of voices advance into the room in the crescendos, with colorful accompaniment furnished by banjo, guitar, harmonica and bass. In addition to traditional tunes such as *Red River Valley* and *I Ride an Old Paint*, the album also features some seldom-encountered gems that enlivened social life in frontier dance halls and refreshment parlors. An added touch of realism is the dubbed-in sound of cattle, wagons and horsemen heard at the beginning of some of the songs. Best of all, the full impact of voices is conveyed without recourse to added echo or wild boost in the bass curve.

Note: Records below are 12-inch mono LP and play back with RIAA curve unless otherwise indicated.

BLOCH: *Shelomo*
BEN-HAIM: *From Israel*
George Neikrug, cello
Leopold Stokowski conducting Symphony of the Air
United Artists UAL-7005

Shelomo, the brilliantly-hued Hebrew rhapsody for cello and orchestra, has never before been heard on disc in the sumptuous sound United Artists provides in this latest version. Sample the first statement of the cello with a compliant pickup of reasonably flat response. As the music slowly cascades to the lower register of the instrument, you'll hear subtle inflection below the point where earlier records mustered a peaked harmonic or faded away entirely. As engineered by Bob Blake, this record is one of the very few to offer the fundamental lows of the cello when heard in the company of an orchestra. Stokowski's concept stresses the majesty of the work's Biblical background. The other piece, a suite by the leading Israeli composer Paul Ben-Haim, draws upon Jewish and Middle East material.

Pipe Organ Masters, Vol. 2
Eugene Gigout, organist
Fulton Productions UF-5A

This disc is part of a remarkable series of six records issued by a small firm in Tulare, Calif. With great patience, Fulton Productions has transferred to disc the playing of famous organists captured long ago on perforated paper rolls similar to those used in player pianos. The music heard here was originally recorded in 1912. The range of frequencies, dynamics and musical expression exceeds that of piano rolls and disc recordings made at that time. The organ rolls were produced by the Welte Co. of Freiburg, Germany. For playback, Fulton has used a specially built pipe organ that duplicates closely the recording instrument destroyed during World War II. Although the chance to hear the playing of past masters such as Eugene Gigout, Max Reger and Lynwood Farnam will mean most to organ fans and students of the instrument, audiophiles will find much that will amaze them in the tonal range covered by this ancient recording medium.

Musica Hungarica
KODALY: *Dances of Galanta; Marosszek Dances*
BARTOK-WEINER: *Two Roumanian Dances*
Antal Dorati conducting Philharmonia Hungarica Orchestra
Mercury MG-50179

Formerly available on the Epic label, this unusual orchestra is a very logical addition to the Mercury instrumental roster. Virtually the entire membership of the ensemble fled from Hungary during the uprising of 1956. Representing most of the leading musical organizations of that country, they have been welded into a fine group by Hungarian-born Antal Dorati, who now spends part of each year working with them in Europe. The Vienna locale (the Great Hall of the Weiner Konzerthaus) is an ideal acoustical setting for the familiar Mercury monophonic technique based on the single omnidirectional microphone. It would surprise no one if Mercury were to rerecord a good deal of the Hungarian repertory under these conditions.

Pieces of Eighty-Eight
Evans Bradshaw Trio
Riverside RLP-12-296

In his second recording for Riverside, the rising young jazz pianist, Evans Bradshaw, provides further explanation of his success to date. He is not afraid to commit himself to a detailed concept delivered with conviction. I suspect that, in the privacy of the home, Bradshaw's work will be enjoyed by jazz fans who are reluctant to admit in public their boredom with some of today's aimless keyboard jazz. In addition to two of his own originals, Bradshaw is backed by alert bass and drums in a varied collection of tunes by Strayhorn, Porter, Gershwin and Gillespie. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N. Y.*

PICTURE-QUALITY CONTROL

For more pleasing TV reception you may wish to add a picture-detail control to your set—several such circuits are shown here

By A. V. J. MARTIN

THERE are several simple ways to improve the picture quality of any television receiver or, more exactly, to better adapt it to the spectator's taste. Such a control is similar to the tone control on radio receivers and, like its audio counterpart, will probably provoke hot discussion.

However, the customer is always right in the long run, and if he likes his picture over-sharp or over-soft, by all means let him have his way. Besides, the very name *P*icture *Q*uality *C*ontrol (PQC) is an important sales point.

The general principle of picture quality control (PQC) is to modify the receiver's overall response curve, either in the post-detection video amplifier or the if amplifier. In this way, one can boost the low or high frequencies in the picture at will.

When low frequencies are boosted, the apparent contrast is better, the blacks and whites are deeper, the large areas are uniform and the overall effect is a general softening of details and outlines. Definition is reduced, and the picture lacks details. This is adequate when the spectator is at some distance from the receiver, where details are lost anyway. At such a distance, the improvement in large areas does much to provide a more pleasing picture.

When high frequencies are boosted, outlines are sharper, the transitions from black to white or white to black are better and the details appear more clearly. The overall impression of high definition and sharpness can be further improved if boosting is carried to the point where a fine white line follows black surfaces and vice versa. A supposedly uniform shade may exhibit changes in density over large areas, and blacks and whites may be less deep.

(Circuits for modifying the response of TV video and video if circuits have been used in a number of American TV sets in the past. The 1956 Conrac Fleetwood sets used a variable capacitor as a manual definition control across the secondary of the second video if transformer. It was used to peak the video carrier and sharpen the picture or attenuate the carrier and soften it. Some Radio Craftsmen RC-100 receivers had a local–distance switch for the same purpose. The switch shorted a section of one of the video if coils to peak the video signal. The DuMont RA-340, Capehart CX-38X and some models of other makes had if circuits whose response varied automatically with agc bias to provide optimum pictures under different signal strengths. (See "Trends in TV Receiver Circuitry" in the July, 1956, issue.—*Editor*)

Let us now examine some practical circuits, first when PQC is applied to the video amplifiers and then when it is incorporated in the if amplifier.

Cathode feedback

A very simple and effective way to control the response curve of a video tube is to include selective negative feedback in its cathode circuit. Usually, this circuit consists of a resistor (R) of a few hundred ohms shunted by a large-value electrolytic capacitor (C) (see Fig. 1-a). When the PQC is included, the circuit looks like Fig. 1-b. The dc cathode bias is provided by resistor R1 and potentiometer R2 in series, the total value of (R1 + R2) being equal to R in Fig. 1-a. The high-value electrolytic capacitor C2 is connected between slider and ground, and a small-value additional capacitor C1 is connected between slider and cathode. When the slider is at the cathode end of R2, the circuit is exactly equivalent to Fig. 1-a and the video response curve is undisturbed. When the slider is at the low end of R2, there is cathode negative feedback which reduces the tube's overall gain. However, R2 is shunted by C1, and the value of this capacitor is such that it practically short-circuits R2 for the highest frequencies of the video spectrum, thus suppressing feedback and insuring full gain of the tube at high frequencies.

If the PQC is not going to be manually controlled, replace R2 with a fixed resistor of the same value, as in Fig. 1-c. This circuit appears in a number of forms in many television receivers, where it is used as part of the video amplifier compensation system to obtain a flat response curve. The purpose of the PQC is different, as we have seen previously. Note that adjusting the PQC does not modify the overall gain for low and medium frequencies. A practical circuit, used in the French *Opera* receivers, is shown in Fig. 1-d.

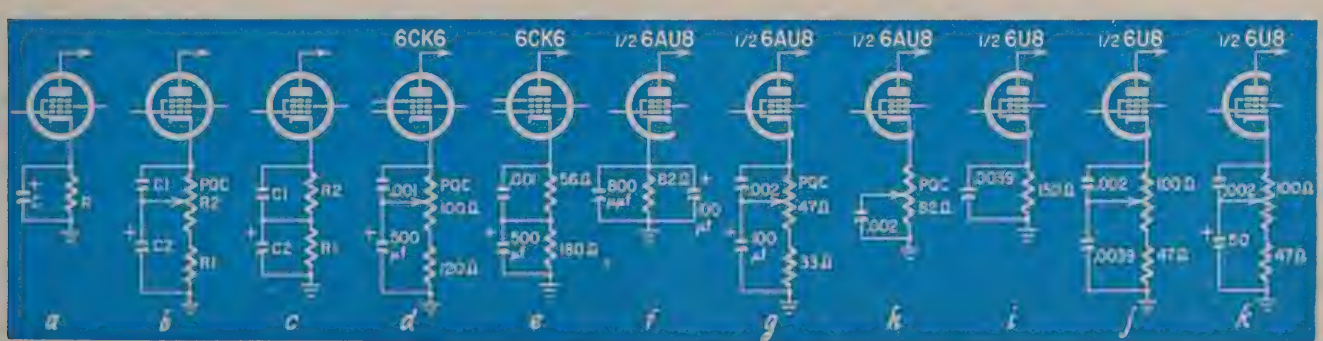


Fig. 1—PQC through cathode feedback.

For the American standard, the value of the small capacitor should be increased to .002 μf.

In some models, the same manufacturer uses a fixed PQC as in Fig. 1-e. Here again, the value of the small capacitor should be .002 μf for the American standard. This circuit is easy to add to an existing receiver, keeping in mind that the total cathode resistance should be the same as the original value. As there is also a slight reduction in video gain the receiver must have some reserve in this respect. This, however, is never bothersome, for the PQC would hardly be installed in marginal cases.

The circuit of Fig. 1-b has been tried on a G-E 17T025 receiver. The original diagram is given in Fig. 1-f, and the modified version in Fig. 1-g. The existing cathode resistor may have a low value, say less than 100 ohms. If this is so, the resistor can be entirely replaced by a potentiometer. This has been done in the G-E receiver, as in Fig. 1-h, with better results. A certain amount of parasitic wiring capacitance is unavoidable, but it does not hinder circuit action. Sometimes it can be made part of the correcting capacitor.

It may turn out that the cathode resistor is shunted by a low-value capacitor as part of the correcting network. This happens in the first video amplifier of a Philco 7L70 represented in Fig. 1-i. There are two possible solutions. Either the existing capacitor is used across the fixed resistor (Fig. 1-j) or it is replaced by an electrolytic capacitor (Fig. 1-k). The latter circuit gives a better range of control. Note that this PQC provides for an increase and decrease of high-frequency gain.

The examples show that installing cathode PQC in the video amplifier of a TV receiver is neither difficult nor expensive. It will, moreover, prove profitable to the alert service technician.

Automatic PQC

A number of receivers use cathode feedback or cathode bias as a contrast control. Simple modifications let you add PQC to such receivers. Moreover, most circuits lend themselves to the installation of automatic PQC. Take the already cited Philco 7L70 as an example. Its second video amplifier uses a 6AQ5 with contrast control in the cathode, as in Fig. 2-a. The simple

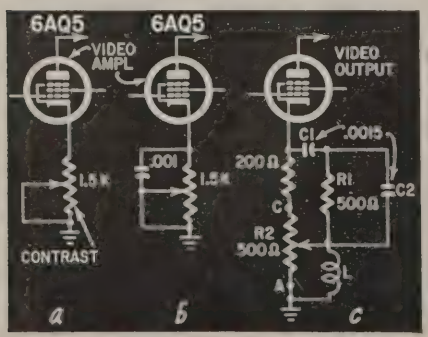


Fig. 2—Evolution of a PQC circuit.

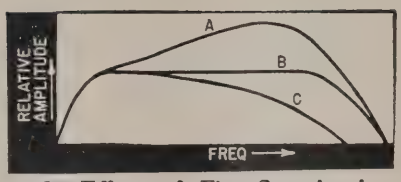


Fig. 3—Effect of Fig. 2-c circuit on video-frequency response.

addition of a .001-μf capacitor (Fig. 2-b) introduces automatic PQC. For distant stations and low-level signals, where high-frequency boosting is undesirable, the slider is at or near the cathode end for maximum gain. This effectively puts the capacitor across a low-value resistance and its effect is small. For local stations and high-level signals, when the picture can stand high-frequency boosting, the slider is at or near ground, the capacitor is connected across a high-value resistance and its effect is maximum. Thus the amount of PQC increases automatically with the level of the received signal.

A somewhat similar arrangement is, in fact, provided in some TV receivers, such as the RCA 21-T series, or the Westinghouse V-23 series. In the latter the shunt capacitor is replaced by the parasitic wiring capacitance, mainly due to the shielded cable connecting the cathode to the contrast control.

Improved cathode PQC

More sophisticated circuits can be devised. An example is given in Fig. 2-c. It represents the video output stage of a German Loewe-Opta model. Neglecting L for the time being, the circuit is similar to Fig. 1-b, except that C1 has been replaced by R1, C1, C2 to obtain a more progressive effect. However, inductor L is also included in the cathode circuit. As its impedance increases with frequency, the cathode feedback increases and the gain decreases for the high frequencies of the video spectrum. Its effect is exactly opposite to that of a capacitor.

Inductor L resonates with its parasitic shunt capacitance near the upper end of the video spectrum, say 3.5 or 4 mc.

The 500-ohm potentiometer does two jobs. When its slider is at the ground end, inductor L is short-circuited and put out of action. Simultaneously, the shunt effect of the capacitive branch C1–C2 is at maximum, so that the negative cathode feedback is reduced and the gain is increased for the upper video frequencies, as before (Fig. 3, curve A).

When the slider is on the cathode side, the shunt effect of the capacitors is minimum. At the same time, the inductor comes into play, the negative feedback is increased and the gain is reduced for the high video frequencies (Fig. 3, curve C).

Between these two extremes, any intermediate effect can be obtained at will. The values of the elements are so chosen that the capacitive and inductive effects just balance each other when the slider is set halfway. This corresponds to the normal response curve (curve B in Fig. 3).

Grid PQC

A different type of control is used on some Nordmende receivers. Since the video amplifier contains correcting inductors to insure that the response curve is flat up to the higher limit of the video spectrum, a simple PQC could be obtained by modifying the inductance value of the compensating coils. However, this introduces some difficult practical problems, mainly due to the distance between the control and the coils. A neat solution has been found by the German makers. The PQC is obtained by varying the inductance of series correcting coil L in the grid circuit of the video amplifier (Fig. 4-a). This coil is wound on a ferrite core, and this core is placed in the field of an electromagnet. The magnetic field can be adjusted to any value with the help of potentiometer R2, and the ferrite core is more or less saturated. Its permeability varies with saturation, and so does the inductance of coil L.

With the slider halfway, coil L is such that it has the correct inductance value for normal flat response. Modifying the current through saturating coil L_S thus provides for lifting or

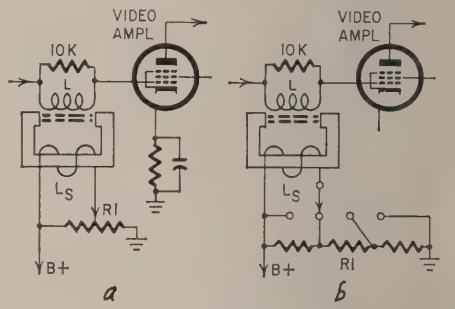


Fig. 4—PQC in the video-amplifier grid circuit.

lowering the high-frequency part of the video response curve.

This continuous PQC can be replaced by a step-by-step control, as in Fig. 4-b. Actually, in the German receiver three pushbuttons are provided. One is labeled "Live", another "Film" and the third "Brilliant." The last one may be added to the other two. This arrangement gives the viewer a choice of light tonalities exactly equivalent to the fixed positions (voice–music) of certain radio tone controls.

PQC in the if amplifier

The PQC can be obtained by modifying the if response curve. Normally, this curve is adjusted so the if value of the carrier corresponds to a loss of 6 db, that is 50%, in gain, relative to the center of the passband. This is indicated by curve A in Fig. 5. For such tuning, the overall response curve of the receiver is flat down to very low frequencies. If, by deliberate mistuning, the if curve becomes curve B, there is an overamplification of the low frequencies. Conversely, curve C attenuates the low frequencies. The effects

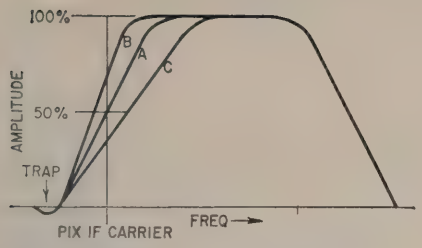


Fig. 5—The effect of modifying the if response curve.

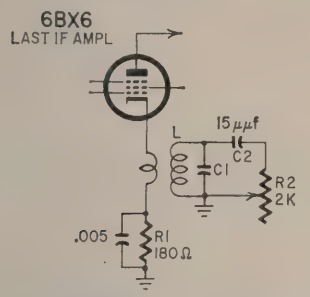


Fig. 6 — Definition-corrector circuit gives PQC by modifying if response.

of such mistunings are well known to the technician; they are very easy to obtain, sometimes quite unintentionally, when tuning the if amplifier.

They can, however, be put to good use for PQC. A simple arrangement is given in Fig. 6. The circuit is included in some French *Oceanic* receivers and is labeled "Definition Corrector." The if corresponding to the carrier is 27.5 mc. Tuned circuit L–C1 is a trap circuit, normally resonating on 27 mc and coupled to the cathode of the last if amplifier tube by a small primary winding.

When potentiometer R2 is at its maximum value, the shunting effect of capacitor C1 on the tuned circuit is negligible and the trap resonates on 27 mc. The tuning of the if amplifier is such that the if carrier corresponds then to an attenuation of 12 db, and the low video frequencies are strongly attenuated (curve A, Fig. 7). When the potentiometer is in the short-circuit position, capacitor C2 shunts the trap circuit and shifts its resonance to 25 mc. The attenuation on the if carrier is then only 3 db (curve B, Fig. 7) and there is an overamplification of the lowest part of the video spectrum.

The setting of the potentiometer provides any intermediate curve between curves A and B, including, at mid-setting, the normal curve with 6-db attenuation on the if carrier.

This circuit may be added across a trap circuit in an existing receiver. It uses only one capacitor and one carbon potentiometer.

Combined PQC

The two principles of picture quality control, in the if and in the video amplifier, can be used jointly in a combined PQC. A commercial circuit, developed by Schaub-Lorenz, appears in a somewhat simplified form in Fig. 8. A trap circuit L1–C is connected at the output of the mixer tube and tuned on 39.5

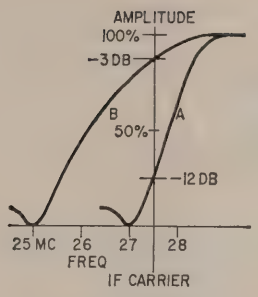


Fig. 7—Effect of Fig. 6 circuit on low video frequencies.

mc, slightly above the if carrier frequency. The setting of potentiometer R1 determines the damping and hence the efficiency of the trap. The result is Fig. 9. The effect is, as before, a variable attenuation on the if carrier.

On the video side, in the anode circuit of the video output tube is correction coil L2. This coil is shunted by potentiometer R2, so that its effect in high-frequency boosting depends on the setting of R2.

R1 and R2 are ganged, and the same control accordingly determines the amount of PQC in the if and video amplifiers.

Amplified PQC

An elaborate PQC has been devised by Schaub-Lorenz. Its principle is entirely different from the preceding circuits. The complete diagram of the video amplifier is in Fig. 10.

Notice first the use of a plate and cathode loaded triode after the detector. The plate circuit feeds the sync separator. The intercarrier sound takeoff is on the grid. The low impedance cathode circuit feeds the video amplifier through a potentiometer which constitutes the contrast control.

The coupling circuit to the 6CK6 video amplifier is more or less standard. It includes series correction coil L and crystal clamping diode D in the grid circuit.

The originality of the circuit is in the use of the pentode section of the 6U8.

Across inductance L appears a voltage which is roughly the derivative of the video signal. That is, for each rapid transition of this signal, a pulse appears across L and is applied to the grid of the pentode part of the 6U8. This pulse

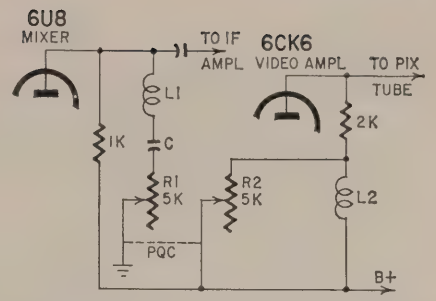


Fig. 8—Combined circuit uses if and video amplifier PQC.

is amplified and reversed in phase at the plate of this tube, and applied to the short-time-constant coupling circuit, which again differentiates it. Each plate pulse is then transformed into a pair of short opposite pulses.

These pulses are added to the original video signal at the grid of the video amplifier. One of the pulses will be in such a direction that it will sharpen the rise of the signal. The other pulse will be in the opposite direction and produce a sharp white outline around black areas and a sharp black outline around white areas.

A trap circuit, tuned to the sound if, has been provided in series with the short time constant coupling circuit.

Potentiometer R1 adjusts the bias of the pentode amplifier and hence its gain.

This circuit does not modify the response curve. It does not increase the bandwidth.

It does, however, improve the apparent definition of the picture by shortening the transitions and setting them against a contrasting outline. All in all, the picture looks sharper and crisper.

END

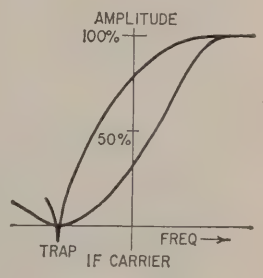


Fig. 9—Effect of pot R1 in Fig. 8 on trap efficiency.

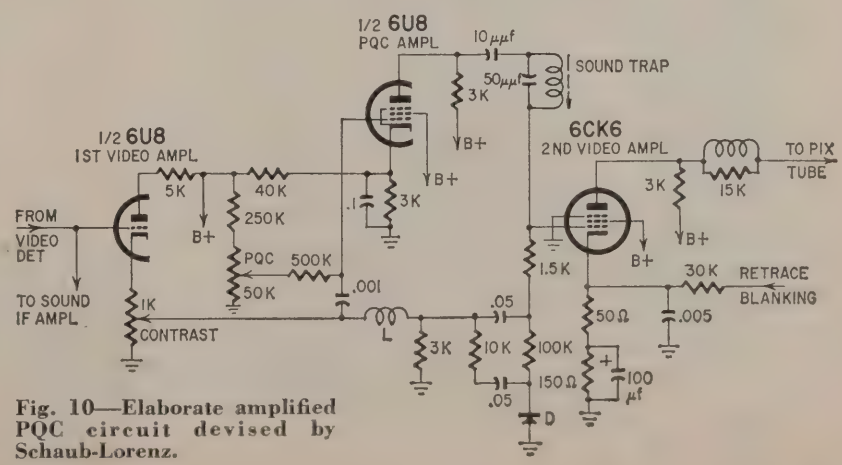


Fig. 10—Elaborate amplified PQC circuit devised by Schaub-Lorenz.

COVER FEATURE

TRANSISTOR TV PORTABLE

Personal TV sets—long a dream of viewers and designers—are now a reality. First of its kind on the market, Philco's new portable introduces a new era in TV viewing

By Allan R. Curll and Paul V. Simpson*

Channel and fine-tuning controls at upper right; on—off—volume, contrast and agc range controls are on left side.

Rear view of cabinet. Manually operated elapsed time indicator keeps track of battery drain.

THE new transistor portable TV's have been developed to take full advantage of the benefits that may be obtained in a transistor design. The light weight (15 pounds) of the pioneer Philco model 2010L shown on the cover and its small size illustrate two of the more important of these.

The receiver operates from 117 volts ac or from its own battery, a function switch changing from one power source to the other. It draws approximately 4.5 watts from its self-contained rechargeable battery. In the AC position, the receiver is isolated from the line by its own built-in stepdown power transformer. This transformer is also used to supply energy for recharging the battery in the charge position.

The television set (Fig. 1) employs 21 p-n-p transistors, 14 diodes and the CR tube. All the transistors in the set were designed and manufactured at the Lansdale plant of Philco Corp.

The tuner uses three MADT (Micro Alloy Diffused Transistor) type transistors, T-1561 rf amplifier, T-1600 mixer and T-1597 local oscillator. Input selectivity is provided by a single tuned parallel resonant circuit capacitively tapped to match the rf amplifier's input impedance and inductively tapped at the 75-ohm point for the monopole antenna. The T-1561 rf amplifier is connected in a neutralized common-emitter circuit. A double-tuned bandpass circuit is used between the rf stage and T-1600 mixer, the input of which is capacitively matched to the double tuned preselector. The mixer is also operated in the common-emitter configuration, and oscillator energy is injected into the emitter for proper mixing action. The oscillator may be regarded as a common-base amplifier in which additional capacitive feedback has been added between collector and emitter to sustain oscillation. Typical system noise factors range from 10–12 db in the high channels (7–13) to 6–8 db in the low band (2–6). Matched tuner power gains vary from 32 to 28

*Philco Corp.

db on channels 2 through 6 and is approximately 18 db in the channel 7-13 region.

The video circuitry

The video if employs four MADT p-n-p triodes designed for 45-mc service. These are used in the grounded-emitter configuration for maximum gain. Conventional stagger tuning is used to obtain an acceptable transient response. The overall gain bandwidth of the if is approximately 70 db at 3 mc. (The first IFT consists of L1, L2 and L3; second IFT, L4, L5, L6; third IFT, L7 and L8; fourth IFT, L9, L10 and L11.)

One of the more serious problems confronting the designer is that of obtaining adequate selectivity for adjacent picture and sound. This problem arises because of the extremely low input and output impedance of the transistor. The input impedance of the type of transistor employed is approximately 100 ohms as compared to the input impedance of a vacuum tube of 20,000 ohms. The if amplifier strip in the 10AT10 chassis as discussed here overcomes this by employing a balanced-T 47.25-mc trap for adjacent sound trapping and a series-tuned 39.75-mc trap for adjacent picture trapping. The trapping ratio is approximately 40 db.

To obtain agc action in a transistor at the present stage of the art, two techniques have received considerable attention. These are forward and reverse agc. Both techniques are employed in this receiver. In the reverse mode, the emitter and collector current decrease with increasing signal strength; in the forward mode, emitter and collector current increase with signal strength. A voltage which goes negative as the signal increases is applied to the base of the first and second IF transistors. This results in a large voltage drop across the large emitter resistor. Less voltage appears across the transistor so the gain of the stage decreases. In the third stage, the base–emitter diode is biased in the reverse direction as the signal increases. As the collector–emitter voltage does not change, the gain of the stage decreases.

The reason for using both forms of agc is that the output impedances of the stages vary with agc. Thus, when the emitter current increases in a stage operating in the forward mode, the bandwidth of the stage increases whereas in a stage that is operating in the reverse mode, the bandwidth decreases, for an increase in emitter current. Thus, to maintain constant bandwidth for varying signal condition, employing both forms of agc action is an aid.

A conventional crystal type video detector drives the first video stage. This stage is used as an emitter follower to obtain correct impedance matching between the detector and the video output stage. The first video is direct-coupled to the detector and agc is obtained from the collector of this stage. A three-position range switch in the collector circuit of this amplifier controls the collector voltage to the tuner and the agc gain to the if.

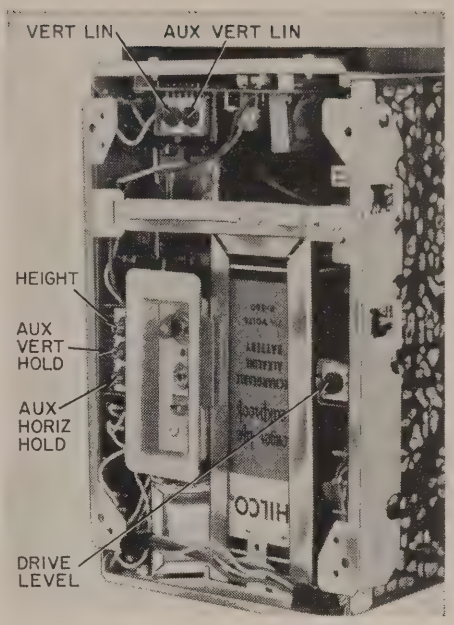
The collector of the video output stage is returned to −12 volts and the emitter returned to +12 volts. In the absence of signal to the base, the collector normally runs at approximately 0 volts. In the presence of signal, it can swing from +12 volts to −12 volts, resulting in a maximum drive to the CR tube of 24 volts.

The sound system

Sound from the emitter follower (first video amplifier) stage is amplified in a 4.5-mc sound if stage which drives a limiter. Limiting is accomplished in this stage by driving the collector of the limiter from saturation to cutoff. The balanced ratio detector drives an audio driver which in turn drives a pair of push-pull class-B output units. The output is approximately 150 mw to a 3-inch speaker.

Sync and noise switch

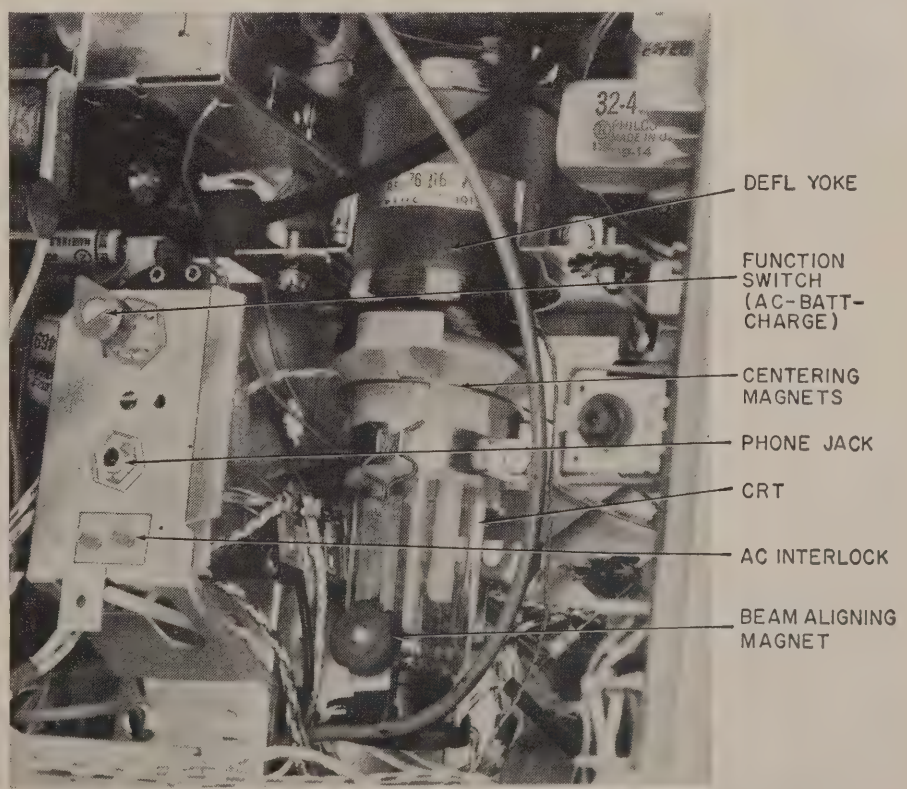
The sync separator is driven from the collector of the video output stage through a double time-constant network. The peak-to-peak signal on the base of this stage is approximately 5 volts with sync negative; sync turns the separator on and drives the collector to saturation. The separator is returned to ground through the collector–emitter junction of the noise-switch transistor, the base of which is returned to the video detector. In the presence of impulse noise, the video detector goes negative about 5 volts. This voltage is ac-coupled to the noise switch through a diode and turns the switch to the off position for the duration of the noise spike. When this stage opens, the sync separator also opens, preventing noise reaching the horizontal and vertical oscillators.



Set's cabinet is removed to show underside of if, video, audio and sync printed-circuit panel and easily reached service adjustments.

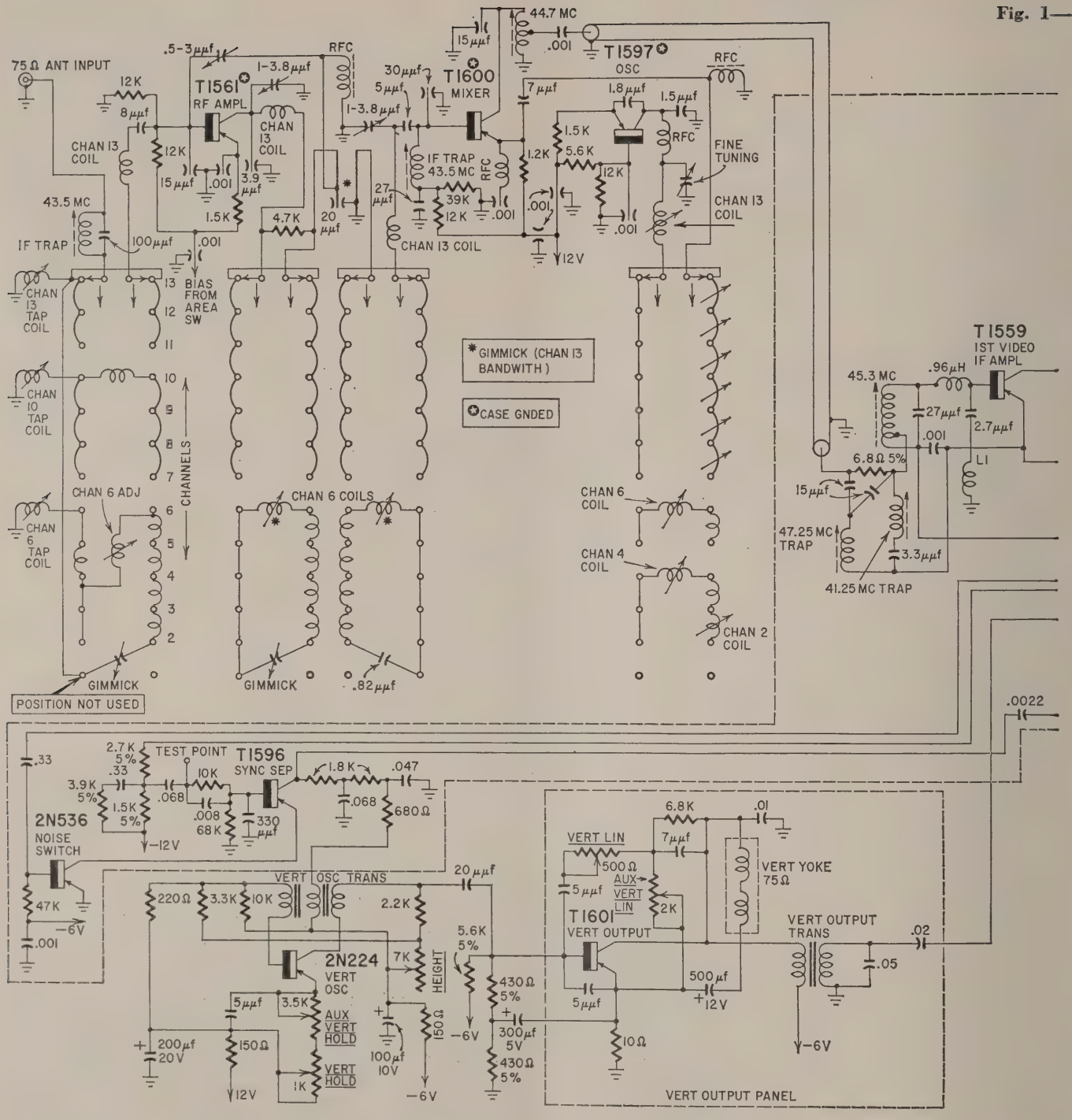
Deflection circuits

The cathode-ray tube used is a 2-inch Lansdale type with a 30-degree deflection angle and a 1-watt heater. A three-stage circuit is used to drive



Closeup of rear chassis with battery removed to show service controls.

Fig. 1—



the horizontal yoke. The first stage is the low-power high-impedance blocking oscillator, driven from a conventional balanced phase comparator.

The buffer circuit, which is essentially a switching device, supplies sufficient current to the output transistor to drive it to full output during scan. It must supply the high reverse-current spike necessary to cut the output transistor off rapidly at the start of flyback. The buffer stage switches at the same time as the output circuit but not at the same time the blocking oscillator is on. This permits the use of a low-power oscillator whose repetition rate is unaffected by variations in buffer or output stage loading.

The output switching transistor supplies the energy for the yoke and high voltage and also for the +12, −12 and +300 volts supplied by the T50, T200 and T400 diodes. The flyback transformer has a turns ratio of approximately 100 to 1 and drives a high-voltage doubler circuit of two 5642 high-voltage rectifiers.

Vertical sync is integrated in a conventional circuit and drives the tertiary of a tightly coupled blocking oscillator transformer. The vertical hold controls are in the emitter of the oscillator to maintain good frequency stability with respect to time and temperature. The vertical oscillator is ac-coupled to the output stage. Considerable feedback is used in this circuit to obtain good linearity.

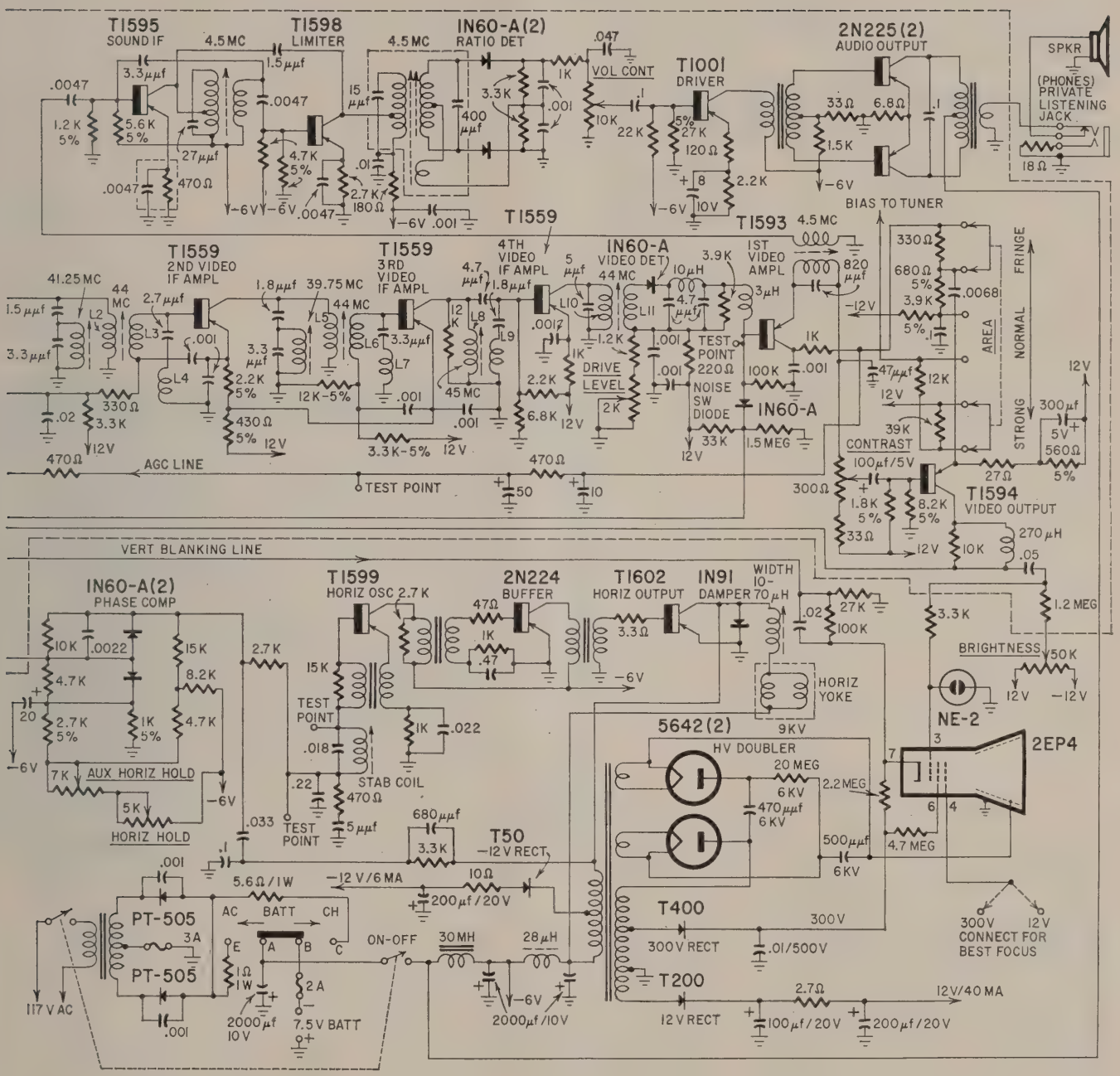
Power supply

The power requirement for the receiver is 700 ma at 6 volts.

The power during ac operation is provided by a stepdown transformer. Full-wave rectification is used to minimize circuit losses and thus prevent unnecessary temperature rise within the receiver. The battery is switched out of the circuit during ac operation to obtain maximum life.

The battery is an alkaline unit that weighs 1.6 pounds. Built into the receiver, it has been designed to operate on a 4-hour discharge cycle. Each dis-

Preproduction schematic of the Philco 10AT10 portable TV chassis.



charge must be followed by a 16-hour recharge. It is recharged simply by plugging into the ac line, may be recharged about 20 times, and will cost in the neighborhood of $5.

Optic system

The arrangement of the optical system and cathode-ray tube is shown in Fig. 2. The diagram also shows the light paths that produce the magnified picture. The light from the arrow (shown as an example) at point A on the CR tube strikes the beam splitter (two-way mirror) at point B. Since this is a reflection surface, it is reflected to point C on the spherical mirror. The light at C must pass through the center of focus D of the mirror. The light rays will also pass through the mirror's center of curvature, E. The intersection of the light rays CD and BE at point F produce a virtual image of the arrow appearing behind the set and magnified.

The optical system has a magnification of 8. The virtual image produced is approximately 8¼ x 11 inches and appears to fall about 4 feet behind the receiver, although it is seen through a viewing aperture only 7½ x 3¾ inches.

The beam-splitter mirror must be designed not only to serve as a reflector but it also must be transparent since you must look through it to see the magnified image. The ratio of transmission to reflection has been chosen to obtain a satisfactory picture under high ambient conditions. END

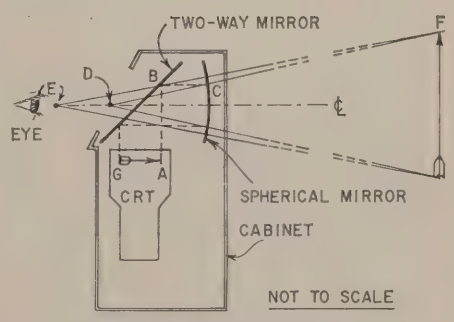


Fig. 2—The optical system.

THOSE INTERNAL TV GHOSTS

When caused by the TV set's circuitry, ghosts can mean trouble. Knowing how to identify an internal ghost and how to scare it away saves you headaches

By JAMES A. McROBERTS

This trailing ghost was caused by a reflected signal.

ALTHOUGH there is another type of trouble known as spooks, here we chase ghosts and want to know if they are in the set or not. If you've ever spent an hour or so orienting an antenna, only to find that the ghost was due to circuit action in the receiver, you know the reason why.

If spacing and intensity of a ghost change when an indoor antenna is substituted for the existing one, you know that the set is not at fault. If the ghost is internal, its spacing and polarity will not change appreciably.

A look at the principal causes of external ghosts shows why. A reflected ghost is due to a difference in the time the reflected signal takes to reach the set. In Fig. 1, path ABC is the route of the reflected signal. The path is longer than the direct route AC, and the ghost arrives after the regular program material. The time delay is constant and can be changed only by reorienting the antenna. There is one ghost for each reflecting surface.

Transmission-line mismatch at the antenna or set can cause ghosts. A corroded contact, introducing a high resistance at the antenna connection, is a prime source of this trouble. A break in the lead-in where it passes through a window is also a frequent cause of ghosts. The ghost will be spaced in proportion to the distance of travel of the standing wave (L1 in Fig. 2) for an antenna mismatch, or distance L2 for trouble at the window.

This type of ghost is temporarily eliminated by using an indoor antenna, since the ghost will disappear or its spacing will change.

Internal ghosts

Closely allied to external ghosts is direct signal pickup by the tuner. If an rf tube in the front end picks up a signal, it will have a time difference with the main signal picked up by the antenna and fed into the set. It may have a different polarity—the main signal may be white while the ghost is black. This ghost appears to the left of the main signal, as a leading ghost.

The fine-tuning control will cause a change in the time delay (and phase, too) of the main signal, affecting the spacing between the two signals. This is known as a tunable ghost—one that will change its spacing and polarity due to tuning. *All tunable ghosts are internal and are caused by the set itself.*

A tunable ghost may be due to other faults, but the direct-pickup type is readily localized. Movement of the body near the TV set (particularly the tuner) will change the ghost's intensity, but will not affect the main signal (unless an indoor antenna is used).

The remedy is to shield the inside of the set, particularly around the tuner. Sheet aluminum can be used for this purpose. Ground the shield to the set's chassis. Another remedy is to install a better antenna (most ghosts of this type come from indoor aerial installations) so that the main signal will be much stronger. The agc system will then reduce the ghost so it will not be prominent.

If a signal is fed back from some later portion of the set into a stage nearer the antenna, a ghost results if the amplitude of the fed-back pulse or picture element is sufficient. (Such

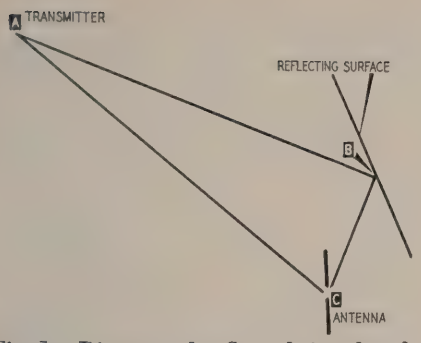


Fig. 1—Direct- and reflected-signal paths result in a trailing, external ghost.

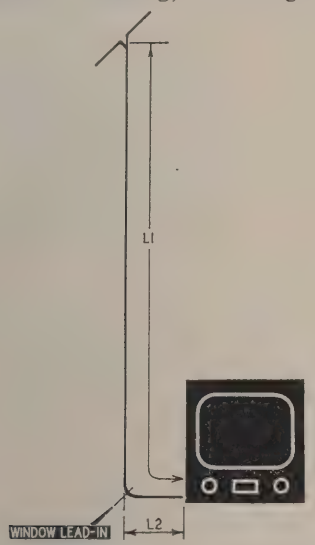


Fig. 2—Mismatching or breaks in antenna lead-in produce ghosts due to standing waves.

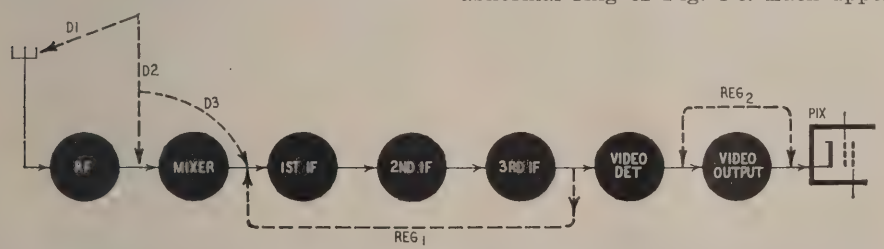


Fig. 3—Block diagram shows pickup and regeneration paths. Direct pickup at D1 and D2 causes leading ghosts. Regeneration paths—REG$_1$ and REG$_2$—produce trailing ghosts.

feedback of sync is often the cause of horizontal jitter.)

Fig. 3 shows several such feedback paths. An if path may be like REG$_1$. It produces a trailing ghost. Spacing depends on the time difference of the main and feedback paths. Any ghost involving the if amplifier can be altered appreciably in appearance by varying the fine-tuning control. The if is affected by such tuning, and hence the appearance of the main signal with a similar change in the ghost. Therefore, a tunable ghost must be internal and pass over some tuned circuit of the set.

Localizing such a ghost is ticklish. Changing the bias on a stage by altering the value of a cathode resistor may furnish a clue—shunt the resistor with another. The appearance of the ghost will change if that stage is part of the feedback path. (The mixer or converter may be considered as an if amplifier for this test.) By finding the stages over which the regeneration path extends, we can find the point of injection of the spurious signal. Then, the necessary steps to stop the feedback are taken—shielding, lead dress, decoupling filters in B-plus, agc lines, etc.

Phase-shift ghosts

Another ghost, with an appearance similar to direct pickup, is the phase-shift type. If this kind of ghost is noted, and is due to misalignment, it will be tunable. It will have an opposite polarity (white ghost for a black signal or vice versa). The tunability proves that the ghost is internal. Proper adjustment of the if tuning will cure one type of such ghosts. Another type is due to the failure of the fine-tuning control to cover the entire range. This ghost is eliminated by adjusting the local oscillator slug or trimmer.

An internal ghost by design is the ring of the peaking coils in the video amplifier–detector sections. High frequencies of the video signal shock-excite these coils into oscillation which is so loaded (damped) with resistance that only two or three cycles of oscillation are permitted. A change in the value of the coil resistance or shunting resistance may cause ring to become excessive (visible).

Fig. 4-a is a typical interstage circuit using ringing coils—shunt and series types. Note associated damping resistors. If the resistance of any damping resistor rises appreciably, the normal ring of Fig. 4-b will become the abnormal ring of Fig. 4-c. Each upper portion of the cycles represents black while each lower peak is white. We have evenly spaced rings decaying in intensity on the screen as a result. These may be distinguished from multiple reflections on an aerial lead-in by the fact that rings follow only short portions of the horizontal lines, while transmission-line reflections follow all abrupt changes whether long or short.

Another way to distinguish ringing from multiple reflections (as with an antenna or set mismatch of the transmission line) is by varying the contrast control. This will reduce the amplitude of the video signal applied to some of the peaking coils at least, and also the intensity of the rings.

Excessive ringing (five or more separate rings or ghosts) is cured by lowering the resistance shunting one or more peaking coils. Shunt each in turn with a resistor of the value given on the set's schematic. The symptom will disappear (to one or two rings) when the bad resistor is found. If excessive ringing is due to a design fault, lower the resistance on all coils. Cut out any old resistors. Their value may change (again) or parasitic oscillation may develop when resistors are paralleled in this circuit.

Interlaced ghost

Another internal ghost is caused by a sidewise displacement of horizontal lines. Trouble stems from a slight shifting of alternate fields. This type of ghost is not tunable and remains constant in value with rotation of the contrast control. Close inspection of the picture will show that each alternate horizontal line is displaced—use a magnifying glass.

The trouble is in the horizontal output tube's grid circuit. Grid leak is too low, the tube is defective, voltages applied are not correct, or the drive control is leaking (capacitor-shunt type). Excessive pickup of vertical pulses by misplaced wiring has also caused this trouble.

Video amplifier regeneration over a path like REG$_2$ in Fig. 3 may cause a ghost. Its intensity will be varied with respect to the main signal by varying the contrast control. Moving leads around the base of the video amplifiers will further confirm this section as the cause. Appearance of a ghost due to video regeneration changes in intensity with different programs and different stations. The usual cures for regeneration apply here. END

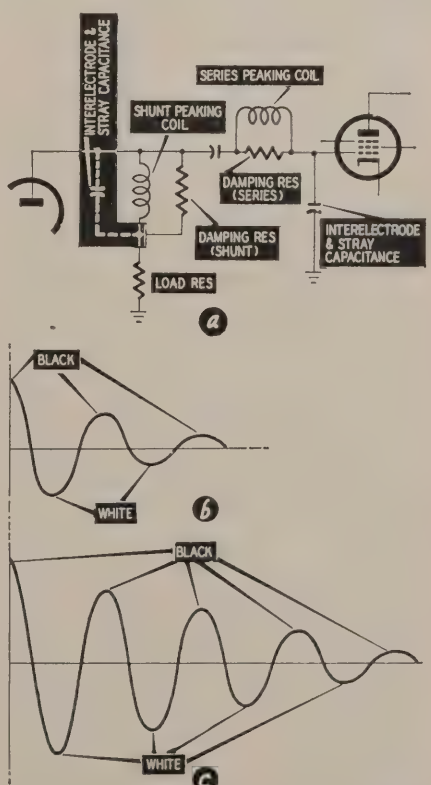


Fig. 4—Interstage ringing coils. When this ring becomes excessive, ghosts appear on the TV set's screen.

TV Service Clinic

conducted by

ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

IT can't be done! Picture analysis is OK, as far as it goes. But by the time a job gets tough enough to find its way into the Clinic, experience proves that we usually need more data than given by picture symptoms.

New tubes have been tried in 99% of the cases. They certainly should have been tried, as a first approach, in the remaining 1%. We shouldn't forget that on occasion two tubes go bad at once. Unless both are replaced, a tube-by-tube check can make a dog out of what should have been a push-over.

When tubes are cleared, it's time to make dc voltage checks. This may seem "elementary" but, man, it would knock your hat off to see how many chassis are worked on for days without making the basic dc voltage measurements. Every incorrect dc voltage has a reason behind it—sometimes the reason is as plain as the nose on my face. Also vice versa.

Again, we have to dig deeper and get more data. Resistance measurements help. In difficult cases, they will sometimes show up shorted turns in a coil which don't affect dc voltages, for example. They can pinpoint bad semiconductors, which also escape dc voltage tests.

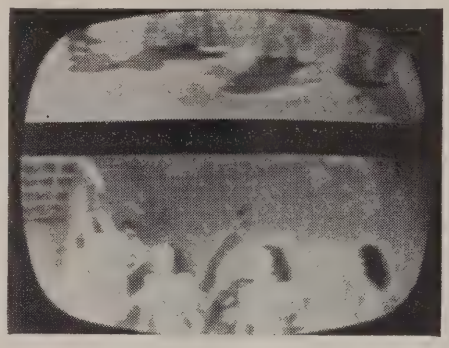
When the soup gets really thick, we must drag out the scope and probes, whether we like it or not. A potful of ac circuit troubles won't show up on either dc voltage or resistance checks. Open capacitors are a classic example. Parasitic oscillation is another. Cross-talk is still another maddening example.

Nobody I know is generator-happy. We don't like to take the time and effort to make sweep-frequency tests. Yet an experienced technician can sometimes pinpoint a circuit fault by looking at the frequency response of a video, if or rf section.

So let's not try to do business from an empty wagon. Let's get all the facts, and make life easier.

Vertical roll

The picture rolls upward in an RCA KCS-81-J. The hold control must be turned to the end of its range. I replaced the vertical sync amplifier, various resistors and a capacitor without success.—P. G., Johnstown, Pa.



The trouble will probably be found in the grid circuit of the vertical oscillator (see Fig. 1). When the time constant is too long, the picture rolls up. The most likely cause is an increase in resistance of the vertical hold control (R187). If necessary, check the 1.2-megohm grid-leak resistor (R186) too.

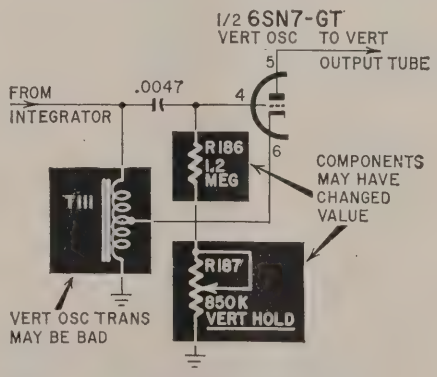


Fig. 1—A picture that rolls upward indicates too long a time constant in the grid circuit of the vertical oscillator.

It is also possible that the vertical oscillator transformer (T111) is faulty. With the picture rolling up, the .0047-μf coupling capacitor would not be suspected. Of course, if it has been replaced with a higher-value unit, the symptom will occur.

Practical conversion?

Is it practical to convert a Zenith 2438RZ1 from a 16EP4 picture tube to a 21EP4?—R. A. B., Burbank, Calif.

The 21EP4 is a good choice. It is easy to sweep, and the present flyback and yoke should be satisfactory. Replace the double ion-trap magnet with a single-magnet type.

Pincushion elimination

I tried to eliminate pincushioning on a Capehart CX37 by placing small bulletin-board magnets at various positions about the picture tube. I did not get much correction. Are stronger magnets advisable? The focus is not too good either. Since pins 6 and 10 are tied together, could better focus be obtained by returning pin 6 to another point?—W. J. F., Youngstown, N. Y.

It would appear that the magnets used were weak. Try magnets from ion traps and I believe you will have better results. The voltage required for focusing can vary greatly from one picture tube to another. I would suggest using a potentiometer (about 500,000 ohms), to adjust the voltage on the focus electrode from zero to full B-plus.

Spurious oscillation

I am having trouble with an Admiral 18X4GZ. There are "intermittent" black lines (three to five), about 3 inches apart on the left side of the screen. They are visible only with signal present and are more pronounced on weaker channels. Pulling any if tube kills the lines. Adjusting the drive control changes their appearance slightly.—R. G. M., Tulsa, Okla.

This type of interference is caused by harmonics from the horizontal sweep system, which are picked up by the if or rf amplifiers, or both. The spurious oscillation in the sweep circuit must be eliminated. This is usually done by connecting 47-ohm resistors in series with the leads to grid, screen grid, and plate of the horizontal output tube. If necessary, also connect 47-ohm resistors in series with the plate and cathode leads to the damper tube. Connections should be made directly at the socket terminals. In severe cases, it is also necessary to connect heater chokes into the heater leads of the horizontal output and damper tubes.

Pix-tube substitution

Can a 17BP4-B be substituted for a 17CP4 in an RCA 17-S-349? The receiver's rated second-anode voltage is 13 kv.—P. D., Hope, Idaho.

The use of an aluminized 17BP4-B in place of a 17CP4 will be satisfactory, provided an accelerating voltage of 13 kv is actually available.

Sweep-alignment problem

I am having some trouble in operating a sweep-alignment setup. I cannot obtain markers on rf curves. The waveforms are only about ½ inch high on rf tests.—C. N., Belleville, N. J.

I would suggest that the outputs from both the sweep and marker generators are weak on the rf bands. This is the most likely cause of marker invisibility and low pattern deflection. The best way to check the generator output is

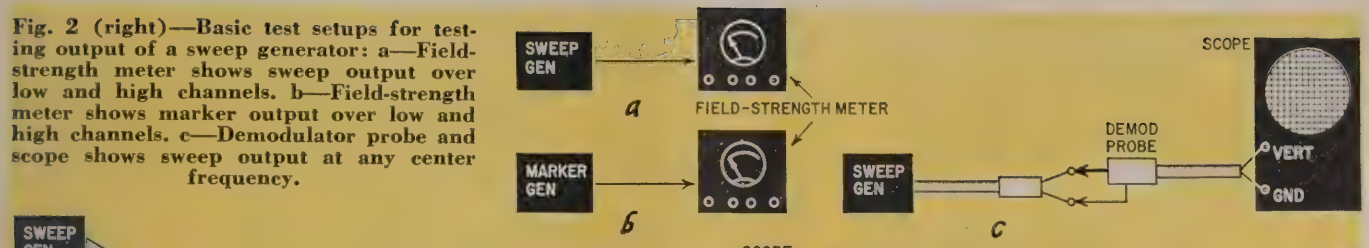
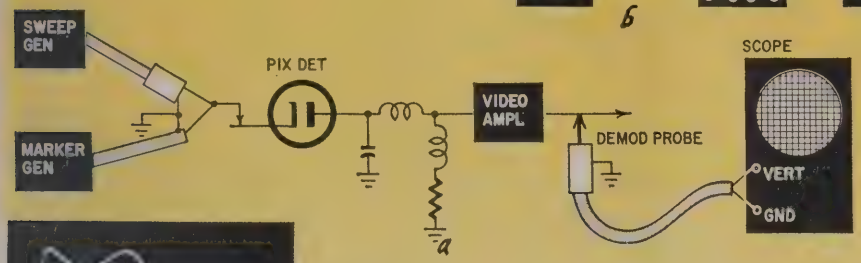


Fig. 2 (right)—Basic test setups for testing output of a sweep generator: a—Field-strength meter shows sweep output over low and high channels. b—Field-strength meter shows marker output over low and high channels. c—Demodulator probe and scope shows sweep output at any center frequency.



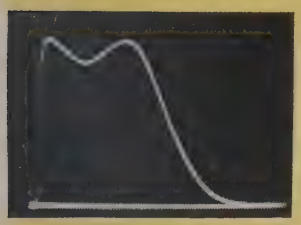
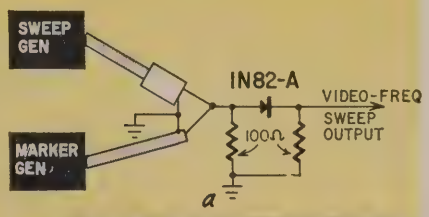
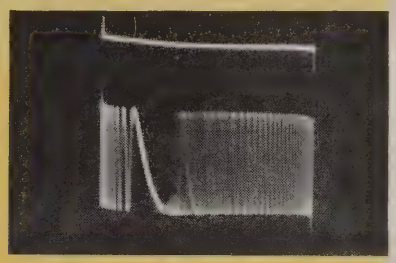


Fig. 3—An extended low-frequency sweep signal is obtained because sweep and marker generators are comparatively isolated: a—Outputs from rf sweep and marker generators are heterodyned through the picture detector to get an extended low-frequency sweep signal. b—A typical video amplifier response curve.

Fig. 4 (below)—Using separate generators with an external modulator produces extended low-frequency sweep signal: a—Modulator termination for extended low-frequency sweep signal. b—Sweep-signal output from modulator extends to about 7 kc before generators pull and lock.





with a field-strength meter, as in Fig. 2. Measure the number of microvolts output from channels 2 through 13. This will give a general idea of the rf output vs frequency. To compare the if output with the rf output, use a demodulator probe and scope (also illustrated in Fig. 2). If the generator has a uniform output on rf and if bands, the same pattern height will be observed when switching bands.

Sweep generator

How can a sweep generator's output be extended down to 40 kc.? Also, please explain a double-ended demodulator probe.—L. M., Detroit, Mich.

The output from a sweep generator is extended to low frequencies by beating the rf sweep output against an rf CW output. One of the simplest methods, for video amplifier testing, is shown in Fig. 3-a. The generator outputs are heterodyned through the picture detector. A typical video amplifier response curve is shown in Fig. 3-b. When a video-frequency circuit or component other than a video amplifier is to be tested, an extended low-frequency video sweep signal can be obtained by using a modulator termination for the generators, as illustrated in Fig. 4-a. A uhf mixer crystal is used to heterodyne the rf sweep and marker voltages. Output extends down into the audio-frequency range. As in Fig. 4-b, the sweep voltage does not "break" until about 7 kc.

A double-ended demodulator probe is shown in Fig. 5. This type of probe is used to test rf circuits which operate in push-pull with both sides above ground. For example, we use a double-ended probe when testing the input impedance of a tuner.

Video overload

A Jackson 17T overloads the picture badly when the contrast control is advanced. The picture gets completely out of shape. The same thing happens when the fine-tuning control is advanced.—F. B., Audubon, N. J.

Information given is not complete, but it appears that the video amplifier is overloading. With reference to Sams 132-8, check:

1. Coupling capacitor C35 from the picture detector to the grid of the video amplifier tube.
2. Voltages at plate and screen of the video amplifier tube.
3. Grid leak R28 in the grid circuit of the video amplifier.
4. Dc restorer tube V8.

12- to 17- or 21-inch screen

I would appreciate data on converting a Zenith 22H20 from a 12UP4-B to a 17- or 21-inch picture tube.—S. F. R., Jacksonville, Fla.

This conversion is not recommended. The 12UP4-B is a 52° tube, and to convert to a 17- or 21-inch tube would call for replacing the flyback, yoke, vertical-output transformer and for extensive rewiring. The advisable course is to try to have the customer trade in the receiver on a large-screen set.

Flyback replacement

A Mirrortone chassis 9049 has a burnt-out horizontal output transformer. Could you tell me what transformer I can use and how to rewire the chassis? —E. B., Buffalo, N. Y.

You can use a Stancor A-8144, Merit A-3038, Triad A-99X, Halldorson Z1802 or Thordarson 26553. You will have to drill one new mounting hole and connect the primary and secondary in series as an autotransformer. To connect the transformer, compare the schematic in the carton with the schematic diagram of the receiver, and wire accordingly.

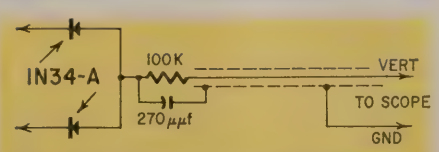


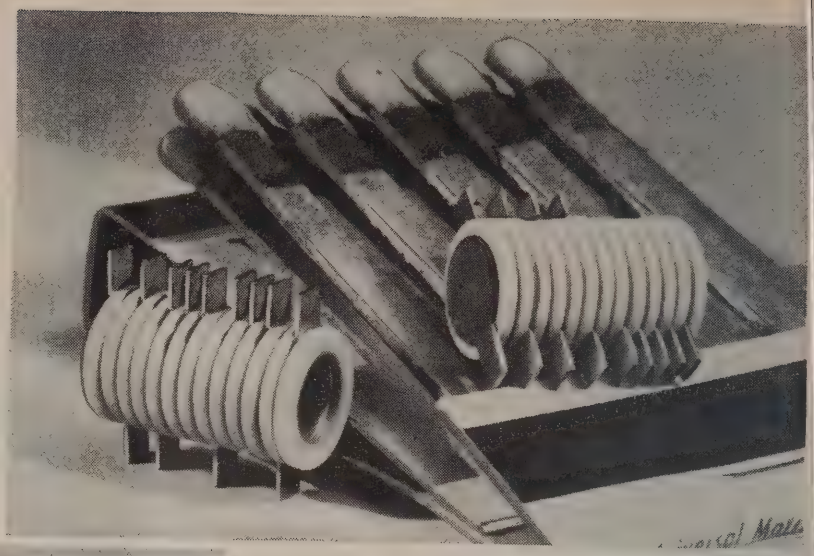
Fig. 5—Circuit of a double-ended demodulator probe.

6CD6 failures

I have been working on a Muntz 17B8 in which the 6CD6 fails prematurely. Voltages and waveforms are normal. Sync is OK. Increasing the resistance of the screen grid resistor reduces picture width. Would it be possible to use two output and damper tubes?—R. R., Lansing, Mich.

This report is typical of parasitic oscillation in the horizontal output circuit. The parasitic voltage does not show up on a scope because its frequency is too high. The tube is overworked and, of course, fails to give normal life. The easiest cure for parasitic oscillation is to connect 47-ohm resistors in series with the grid, screen-grid and plate leads of the output tube. Connect the resistors directly at the socket terminals, because it is the leads themselves which are the parasitic resonant circuits. It is sometimes necessary also to connect standard heater chokes in series with the heater leads. Normal tube life depends upon avoiding excessive cathode current. This can be controlled by increasing the value of the screen resistor. Picture width can be increased at the expense of brightness by inserting 1 or 2 megohms of resistance in series with the high-voltage lead. END

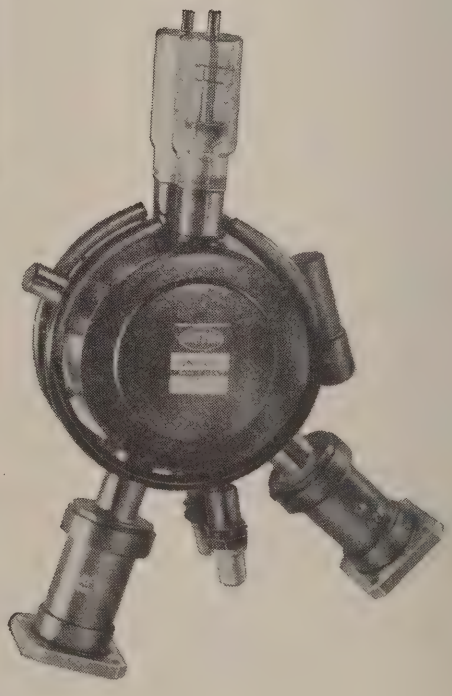
what's new?



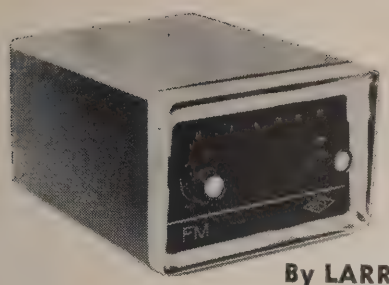
MODULAR CIRCUITS include tubes without heaters, microminiature resistors and capacitors stable over several-hundred-degree temperature changes. Circuits like those shown are multivibrators and amplifiers. TIMM's (Thermionic Integrated Micro-Modules) operate in high-temperature environment, use the heat to cause cathode emission. A circuit only ⅓ x 2.6 inches long holds 10 diodes, 14 triodes, 14 resistors, 6 capacitors. TIMM's are a product of General Electric Co.'s research.

BIGGEST SPEAKER driver ever made for home high fidelity use is this 30 - inch Electro - Voice giant woofer here balanced by Elaine Lee of the E-V staff. The polystyrene cone works down to below 18 cycles.

AUTOMOBILE MIRROR RADIO has 5 transistors, ferrite antenna, draws 500 ma at 12 volts, delivers up to 2.5 watts audio into speaker (not contained in mirror). Made initially for European sports cars, the radio has a possible disadvantage: inviting vandalism. The Voxson Vanguard is made by F.A.R.E.T., Rome., Italy.



SUPER-POWER MICROWAVES from regular ac power with efficiencies up to 80% may be made possible with the amplitron, heart of "sky-hook" system (RADIO-ELECTRONICS, page 6, July) proposed by the Raytheon Co. to keep fixed platforms in the sky by beaming power to them by radio. The Amplitron is a crossed-field vacuum tube which combines high efficiency, high frequencies (at least 10 centimeters), high power (megawatts), wide-band characteristics (10% of frequency) and low input voltages. Shown above the two top electrodes are heater input; lower left, rf input; right, microwave power output.



CONVERTER puts FM in your car

By LARRY STECKLER
ASSOCIATE EDITOR

WITHIN a few years FM radio will be standard equipment in the American car. It will be used to supplement the present AM radio. But if you want FM radio for your car today, you have to go out and get a special piece of additional equipment. It may be a straight FM receiver designed for 6- or 12-volt operation or it may be AM–FM. Then there's a converter, the Gonset model 3311. It is a standard FM tuner as far as the output of its discriminator. But the detector's output is used to modulate an 800-kc oscillator which feeds the standard AM car radio. In other words, the Gonset converter takes a vhf FM signal and translates it into an AM signal.

The unit is simple and compact. It covers the entire FM band (88–108 mc) and is easily installed. The job takes only about 15 minutes. A U-shaped bracket fits around the converter and two self-tapping screws fasten the works under the dash.

Electrically, the installation is just as simple. All you do is disconnect the auto antenna from the AM radio and plug it into the receptacle on the back of the converter. The lead from the converter, terminated in an antenna plug, slips into the AM radio's antenna jack. Then you clip the power lead, a long red wire equipped with an insulated alligator clip, onto the hot terminal of your heater switch or an unused terminal of the ignition switch. Now you're ready to listen to FM as you travel along the road.

Circuit details

The unit's circuit is stable and noise-free. It operates very simply (see diagram). With selector switch S1 in the AM position, the incoming signal is fed through capacitor C22 to the AM receiver. In this position power to the translator is turned off.

Placing switch S1 in the FM position supplies power to the converter and connects the antenna input to the cathode circuit of the first rf amplifier, half of a 12EC8 (V1-a). This tube operates as a broadband grounded-grid amplifier. As well as having a low noise figure, grounded-grid operation provides the low input impedance necessary for matching to the quarter-wave antenna.

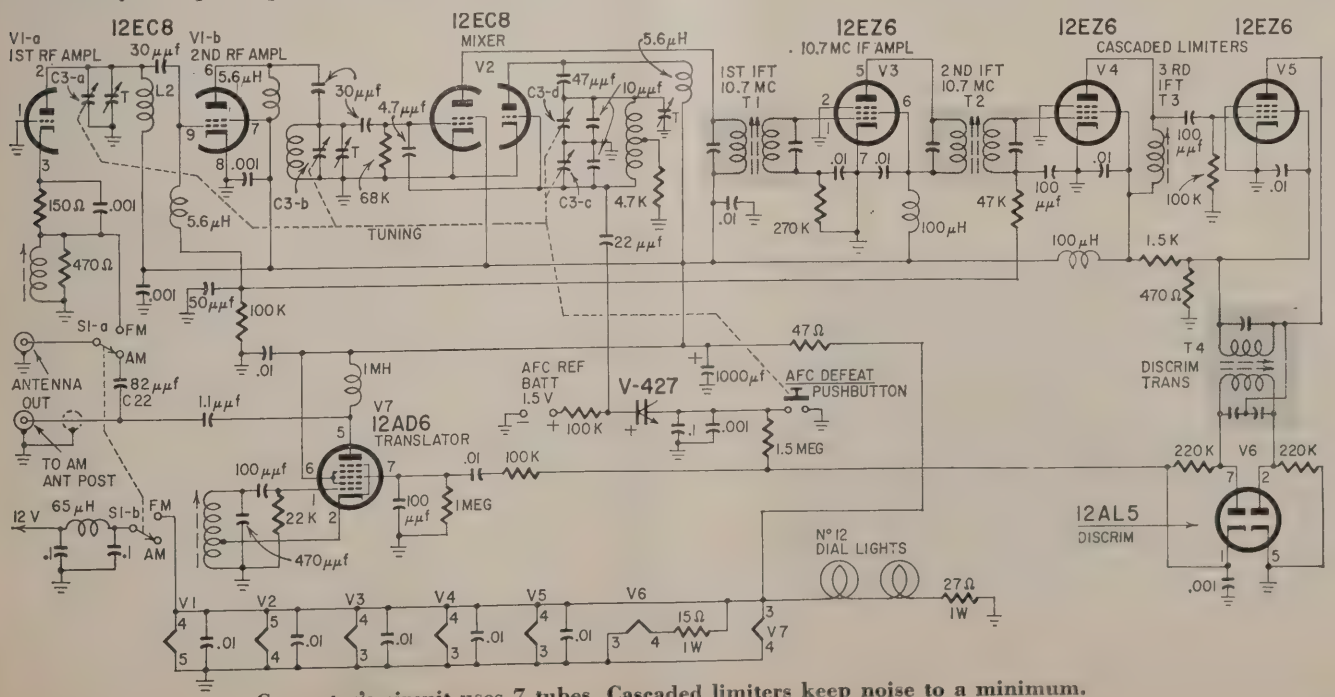
V1-b is the second rf amplifier. Rf coil L2 is tuned by capacitor C3-a. Sections C3-b and C3-c of this ganged capacitor tune the mixer and oscillator circuits. The output from V1-b is then fed to the mixer's grid (V2). Also fed to this point is the afc-controlled oscillator output.

The mixer's output is a 10.7-mc signal which is coupled to if amplifier V3, a 12EZ6, through transformer T1. V4 and V5, also 12EZ6's, operate as tuned cascaded limiters, and are largely responsible for the converter's noise-free operation. V4 is coupled to a 12AL5 Foster-Seeley discriminator through transformer T4.

The detected audio signal is then fed to translator tube V7, a 12AD6. This tube is an oscillator (similar to a phono oscillator) tuned to 800 kc, and modulated by the audio from the detector. Its output is fed to the auto radio where it is handled just as any other incoming 800-kc AM signal would be.

Afc is provided through a Varicap circuit. The Varicap is a voltage-variable capacitor used to keep the FM oscillator on frequency. For a description of how this type of circuit works, see "Using the Varicap" in RADIO-ELECTRONICS, May, 1958, page 57.

Naturally, with this arrangement, the fidelity is no better than that of the AM set it is used with. To get the full benefit of FM sound, simply disable the translator stage by pulling the tube. Then take your output from pin 7 of this tube's socket and feed it into whatever hi-fi amplifier system you intend to use. END



Converter's circuit uses 7 tubes. Cascaded limiters keep noise to a minimum.

TRANSISTORS... *fact and fiction*

Part II — There are easy ways to service transistor equipment. Some of these techniques are described here

By LOUIS E. GARNER, JR.

LAST month we saw how some common accepted thoughts on transistors are not true. Now that we've been steered back onto the right course we are ready to survey the servicing end of transistor circuitry.

Technicians working with transistors will frequently encounter circuits which have no counterpart in vacuum-tube work. And professional service technicians called on to maintain and repair transistor receivers, amplifiers and other equipment may sometimes find that their familiar service methods must be modified to get acceptable results. To see why these things are true, let's take a look at a few commercial transistor circuits.

The schematic for the audio amplifier used in the Westinghouse H-602P7 receiver is shown in Fig. 1. Four 2N217 p-n-p transistors are used—one as a preamplifier, one as a driver and two as a push-pull power amplifier. The common-emitter circuit configuration is used in all three stages. In operation, the first stage is R-C-coupled to the driver, which, in turn, is transformer-coupled to the output amplifier.

While this circuit seems conventional at a quick glance, it has two features seldom found in corresponding vacuum-tube audio amplifiers. First, note that the VOLUME control consists of two ganged potentiometers—R1-a and R1-b. One is connected ahead of the first amplifier, the second between it and the driver stage.

There are several reasons for using such an arrangement. It provides a better control over volume, it minimizes the effect of any noise developed in the first stage at low signal levels and, by controlling the input to the first stage, it reduces the possibility of overloading on strong signals.

The second interesting feature is the method used to supply dc operating currents. The emitters are floated above circuit ground, while the collectors are returned through their loads direct to ground. In a vacuum-tube amplifier, this would be analogous to applying a high negative voltage to the tubes' cathodes and returning their plates to ground.

Such an arrangement, while not unique as transistor circuits go, could cause a service technician to do a double take, since a check of output stage collector-to-ground voltage would give a reading of zero volts. Imagine measuring zero volts plate to ground in a properly operating vacuum-tube audio amplifier!!

To avoid hard-to-interpret voltage readings when checking transistor circuits, it is best to check to the common electrode of each stage as a reference point. Thus, measurements could be made from base to emitter and from collector to emitter.

Even with this technique, the technician may encounter difficulties. Note that there is a difference of only 0.1 volt between the base and emitter of the driver stage. This is not an unusual bias voltage in transistor circuits (remember that bias currents rather than voltages are important in transistor operation) but may give very little deflection on, say, the 5- or 10-volt range of a standard multimeter. The technician making a quick check may conclude, in error, that there was zero bias.

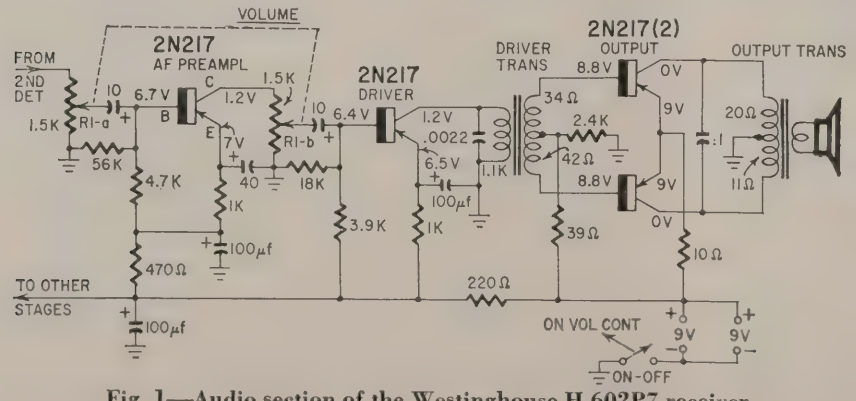


Fig. 1—Audio section of the Westinghouse H-602P7 receiver.

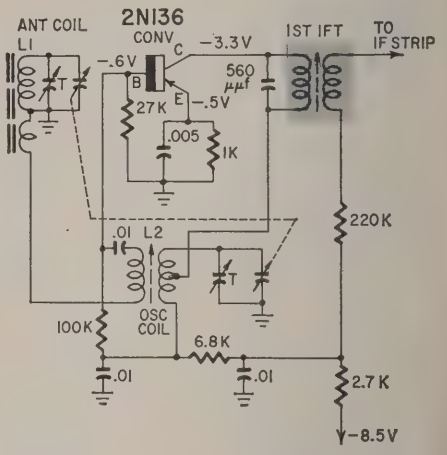


Fig. 2—Converter used in the G-E 675 transistor receiver.

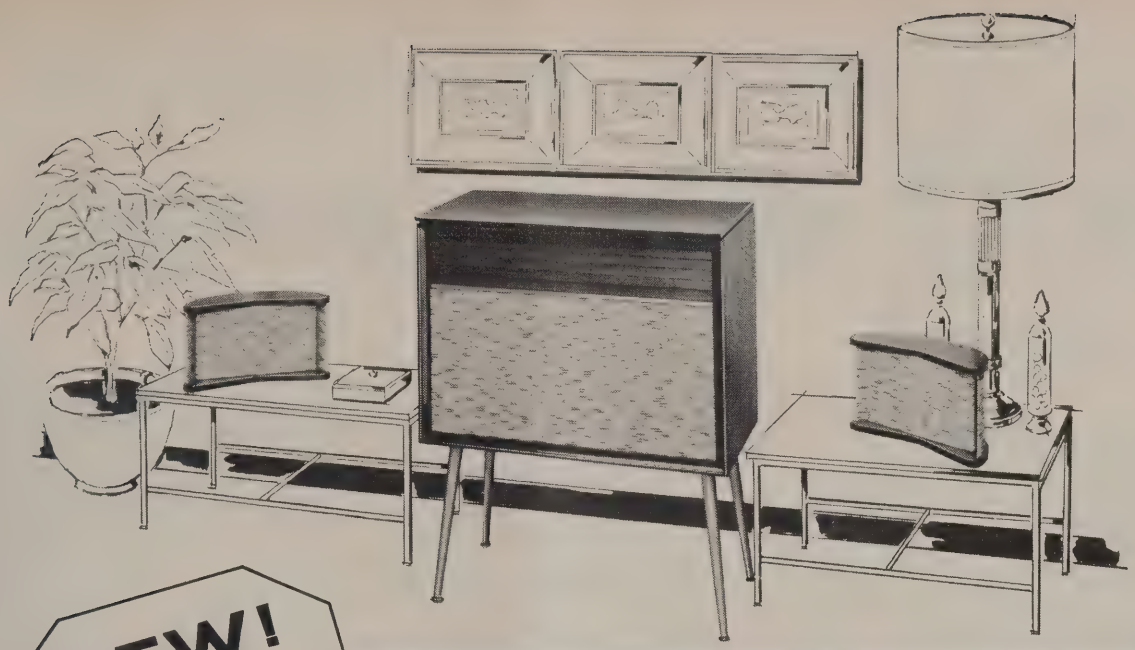
Transistor converter

Measurement difficulties may be encountered in rf and if stages as well as in audio amplifier circuits. Refer to Fig. 2, where the schematic of the converter used in the G-E 675 receiver is shown.

Here, a 2N136 p-n-p rf transistor is used as a combination local-oscillator–mixer. A common-emitter circuit configuration is employed. In operation, L1 serves as the antenna coil and L2 as the oscillator coil, providing feedback between collector and base circuits to start and sustain oscillation.

When working with vacuum-tube receivers, it is standard practice to check the operation of a local oscillator by checking for a negative bias voltage across the oscillator's grid resistor. If there is a voltage here, the oscillator is working (although not necessarily at the right frequency). If not, the oscillator is dead.

A number of technicians have tried to use this same technique to check transistor oscillators, with very unsatisfactory results.



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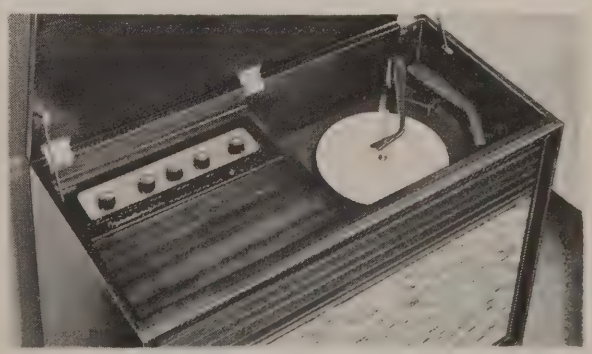
(cabinet legs included; end tables not included)

HI-FI STEREO SYSTEM KIT

For the first time anywhere . . . a stereo-kit package, ready-to-play after only a few hours assembly time and complete with cabinet, stereo amplifier, stereo record changer, bass woofer and stereo speaker wings. And the unbelievably low price sets an unprecedented record for stereophonic systems of this quality anywhere on the market. One of the factors behind this phenomenal achievement is the introduction of the revolutionary stereophonic "sum and difference" amplifier used in this kit—licensed in kit form exclusively by Heath Company from CBS Laboratories. This unique development in audio science employs a new principle of stereophonic reproduction. The single chassis amplifier separates the individual stereo channels by utilizing the sum and difference of the total signal and directing the sound to the appropriate right and left channels, reproduced by the stereo wing speakers. The centrally located woofer reproduces the non-directional bass frequencies. The result of this modern stereo reproduction is a breath-taking experience of sound coming to you with depth and direction seldom achieved by conventional stereophonic methods. The beautifully styled console cabinet houses the stereo amplifier, stereo record changer and low-frequency woofer. Controls on the handsome black and gold amplifier panel consist of: on-off switch, bass and treble tone controls, input selector switch and level balancing control. The new CBS sum-and-difference or matrix-type circuit employs only four tubes and is extremely easy to assemble. The woofer, mounted behind the attractive grille cloth, is a high compliance 8" speaker capable of 30 cycle response when housed in the acoustically designed ducted-port enclosure. The specially designed crossover employs a dual bass-mixing 250 cycle network. The twin stereo speakers are 6" x 9" extended range dual cone oval speakers. The completely automatic, four speed record changer employs a ceramic stereo cartridge with micro-groove diamond stylus capable of obtaining the best from the latest stereo or LP monophonic recordings. A 45 RPM spindle is also included for 45 RPM monophonic or stereo records. Separate inputs are provided for AM/FM tuners or multiplex. Both in styling and performance, the all-new SD-1 Stereo offers you the greatest Heathkit value in years. Shpg. Wt. 88 lbs.

- Complete—No "Extras" to Buy
- Revolutionary Stereo Amplifier
- Assemble in Just a Few Hours From Easy Step-By-Step Instructions
- Beautifully Styled Cabinetry
- Stereo Sound With Such Impact You'll Find It Hard to Believe!

SPECIFICATIONS—Overall System Frequency Response: ±5 db, 30-16,000 cps. Amplifier: (push-pull conditions except where specified). Power versus Distortion: 10 watts, less than 3% THD from 30-16,000 cps. 9 watts, less than 2% THD from 30-16,000 cps. 1 watt, less than 0.7% from 30-16,000 cps. Peak Power: 20 watts: Mid-range individual channel power, 5 watts. Frequency Response: Tuner input, tone controls in mid-position, 1 watt level, ±1 db, 30-16,000 cps. Ceramic cartridge input—equalized for RIAA characteristics. Input Sensitivity: 0.1 volt at 1000 cps to each tuner input for 10 watt output. Hum and Noise: 70 db below 10 watt level with inputs shorted. Channel Separation at Significant Frequencies: (2 watt level on operating side). 250 cps—29.0 db. 1 kc—34.0 db .2 kc—35.0 db. 2 kc—35.0 db. 5 kc—36.0 db. 8 kc—37.0 db. 12 kc—35.0 db. 16 kc—29.0 db. Overall Channel Separation: using RCA test record #1427-1, cartridge supplied, 1000 cps, 20 db. Bass Tone Control 50 cps: accentuation 8 db. Attenuation 9 db. Treble Tone Control 10 kc: accentuation 9 db. Attenuation 7 db. Power Requirements: 117 volts, AC, 60 cycles, 75 watts. Crossover Network: crossover freq.—250 cps. Attenuation rate 12 db per octave. Power rating—5 watts per channel. Changer: speeds—16, 33⅓, 45, 78 rpm. Cartridge: ceramic stereo, out-of-phase connected (.0008" diamond stylus). Cabinets: dimensions—main cabinet, 30" wide x 34½" high x 15" deep. Satellite speaker, 14¼" wide x 8" high x 6½" deep.



EASY TIME PAYMENTS

The thrills of stereo sound from this New Heathkit Stereo System can be yours NOW . . . while you pay in easy installments.

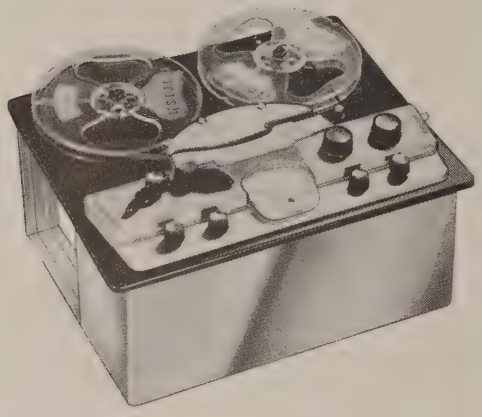
a complete line of stereophonic and monophonic

NEW! from the HEATHKIT AUDIO LABS

HEATHKIT®

Tape Recorders

Field Tested for One Year



SPECIFICATIONS—Tape Speed: 7.5 and 3.75" per second. Maximum reel size: 7". Frequency response: (record-playback): ±2.5 db, 30-12,000 cps at 7.5 IPS. ±2.5 db, 30-6,500 cps at 3.75 IPS. Harmonic distortion: 1% or less at normal recording level; 3% or less at peak recording level. Signal-to-noise ratio: 50 db or better, referred to normal recording level. Flutter and wow: 0.3% RMS at 7.5 IPS, 0.35% RMS at 3.75 IPS. Heads (3): erase, record, and in-line stereo playback. Playback equalization: NARTB curve, within ±2 db. Inputs (2): A and B stereo channels. Output levels: approximately 2 volts maximum. Output impedance: Approximately 600 ohms (cathode followers). Recording level indicator: professional type db meter. Bias-erase frequency: 60 kc. Timing accuracy: ±2%. Power requirements: 105-125 volts AC, 60 cycles, 32 watts. Dimensions: 15½" W. x 13¼" D. total height 10¾". Mounting: requires minimum of 8½" below and 1½" above mounting surface. May be operated in either horizontal or vertical position.

NEW PROFESSIONAL-TYPE TAPE RECORDER KITS

Designed to take their place in the finest of hi-fi systems, the new models TR-1C and TR-1D Tape Recorders will provide superb performance for years to come. These completely field tested, precision engineered instruments provide monophonic record and playback in the TR-1C or monophonic record and playback plus stereo playback in the TR-1D.

The mechanical assembly, with fast forward and rewind, is completely finished and adjusted—you build only the tape amplifier. Easy to assemble, the amplifier features two circuit boards which virtually eliminate wiring errors and assure the high stability necessary for consistently good results.

Low noise EF-86 tubes in input stage and push-pull bias erase oscillator assure maximum freedom from hum and noise in recording and playback.

Two inputs are provided (mike and high level line) for recording from microphone, preamplifier, tuner, phono, or TV. In the TR-1D, a separate playback channel with cathode follower output is provided for each stereo track—one of the stereo channels is used for monophonic playback.

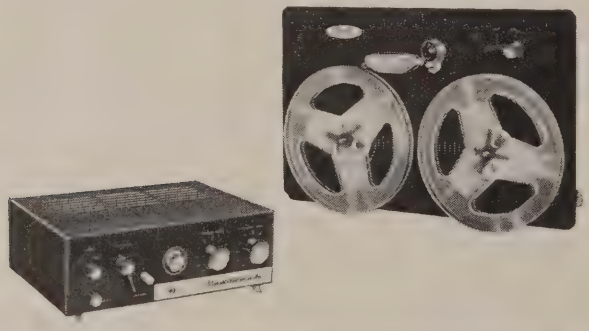
Separate record and playback heads and amplifiers allow monitoring from tape while recording. Built-in sound level meter indicates proper recording level and bias for top quality recordings. A pause control allows instant starting and stopping of tape for accurate cueing and tape editing. Kit includes counter for cueing and editing ease.

The precision tape mechanism features heavy duty fan cooled motor, balanced flywheel, long-life bearings, and positive acting braking system. Push button provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch minimizes the possibility of accidental erasing. The handsome styling includes plastic escutcheon in soft gold mounted on semi-gloss black panel with black knobs with gold inserts. Complete instructions provided for assembly and operation. This outstanding kit offers a combination of features found only in higher priced professional tape decks selling for $350 to $400.

MODEL TR-1C Monaural Tape Deck: Has all features of model TR-1D with the exception of stereo playback. Shpg. Wt. 30 lbs. **$159.95**

MODEL TR-1D Stereo Tape Deck: Provides monaural record and playback and stereophonic playback of the pre-recorded tapes (stacked). Shpg. Wt. 30 lbs. **$169.95**

MODEL C-TR-1C Conversion Kit: Converts model TR-1C to include stereo function of model TR-1D. **$19.95**



NOW! FULL STEREO CONVERSION FOR TR-1A OWNERS

MK-4 Half-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of half-track stereo program material. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AH. **$62.95**

MK-5 Quarter-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of quarter-track stereo. Allows playing stereo both ways on standard tape for twice the playing time or four times playing time with monophonic recordings. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AQ. **$62.95**

HEATHKIT®

NOW! TWO NEW STEREO-MONO TAPE RECORDERS IN THE TR-1A SERIES

Our most versatile tape recorder kit, the model TR-1A now can be purchased in any one of three versions. You can buy the new half-track (TR-1AH) or quarter-track (TR-1AQ) versions which record and play back stereo and monophonic programming, or you can buy the original monaural version (TR-1A) and add either half-track or quarter-track stereo provisions later using the MK-4 or MK-5 Conversion kits. The tape deck is extremely simple to assemble and uses precision bearings throughout the rugged mechanism assuring long and faithful service. One control lever selects all tape handling functions on the deck, greatly simplifying operation. Speeds of 7.5 or 3.75 IPS are available. Flutter and wow are held to less than 0.35%. Each tape preamplifier features NARTB playback equalization, separate record and playback gain control, cathode follower output and provision for mike or line input. Record level is indicated on "magic eye" tube. A safety interlock is provided to minimize accidental erasure of tape. Filament balance control allows adjustment for minimum hum level. Cathode follower output from playback channel is approximately 600 ohms impedance. Two circuit boards are used for easy assembly. Supplied with attractive vinyl-clad steel cover in black leather texture, with inlaid gold design. Templates and instructions provided for panel mounting or equipment enclosure installation.

NOW AVAILABLE IN THREE MODELS!

MODEL TR-1A: Monaural record/playback with fast forward and rewind functions. Shpg. Wt. 24 lbs. **$99.95**

TR-1A SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 50-12,000 cps. 3.75 IPS ±3 db 50-7,000 cps. Signal to Noise Ratio: Better than 45 db below full output of 1.25 volts /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 60 kc (push-pull oscillator).

MODEL TR-1AH: Monaural and half-track stereo record/playback with fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

TR-1AH SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 45 db below full output of 1 volt /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 55 kc (push-pull oscillator).

MODEL TR-1AQ: Monaural and quarter track stereo with record/playback fast forward and rewind functions. Shpg. Wt. 35 lbs. **$149.95**

TR-1AQ SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 40 db below full output .75 volts /channel. Harmonic Distortion: Less than 2% at full output. Bias Erase: 55 kc (push-pull oscillator).

monophonic or stereo Hi-Fi

HEATHKIT®

Program Sources

NEW

MODEL FM-4

$34.95

SPECIFICATIONS—Tuning Range: 88—108 mc. Quieting Sensitivity: 2.5 uv for 20 db of quieting. 3.5 uv for 30 db of quieting. 25 uv for maximum quieting (45 db). IF Frequency: 10.7 mc. Image Ratio: 45 db. AFC Correction Factor: 75 kc per volt. AM Suppression: 25 db. Frequency Response: ±2 db 20-20,000 cps. Harmonic Distortion: Less than 1.5%, 1100 uv, 400 cycles 100% modulation. Intermodulation Distortion: Less than 1%, 60 cycle and 6 kc mixed 4:1 1100 uv, 30% modulation. Antenna: 300 ohms unbalanced. Output Impedance: 600 ohms (cathode follower). Output Voltage: nominal .5 volt (with 30% modulation, 20 uv signal). Power Requirements: 105-125 volts 50/60 cycle AC at 25 watts. Overall Dimensions: 4¼" H. x 13¼" W. x 5½" D.

NEW HIGH FIDELITY FM TUNER KIT (FM-4)

This superbly designed unit incorporates advancements in circuit design with features asked for by hi-fi fans everywhere. Better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with defeat switch, flywheel tuning and prewired, pre-aligned and pretested tuning unit . . . bring you the finest in FM listening entertainment. The exceptionally clean chassis layout, pre-aligned IF transformers and the prewired, pre-aligned tuning unit insure ease of construction with no further need of alignment after the unit is completed. The five tube circuit features a generous power supply utilizing a silicon diode rectifier for cool running operation and low power consumption. The attractive styling of the FM-4 features a vinyl-clad steel cover with leather-like texture, soft black front panel, set off with brushed-gold trim and new soft evenly-lit dial scale. A multiplex adapter output is provided. Feature for feature the FM-4 offers the most outstanding dollar value in FM entertainment available today. Shpg. Wt. 8 lbs.

MODEL PT-1

$89.95

MONOPHONIC-STEREO AM-FM TUNER KIT (PT-1)

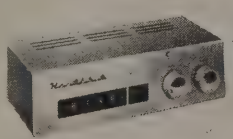
Outstanding features in both styling and circuitry are combined in this 16-tube deluxe stereo AM-FM combination tuner to bring you the very finest of program sources for your listening enjoyment. Features include three printed circuit boards for easy construction and high stability—wired, pre-aligned 3-tube FM tuning unit—built-in AM rod antenna—tuning meter—automatic frequency control (AFC) with on-off switch—and flywheel tuning. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. AM and FM circuits are separate and individually tuned so they can be used simultaneously for stereo applications. Cathode follower outputs with individual level controls are provided for both AM and FM, with a multiplex adapter output provided. A tuning meter and flywheel tuning combined with two edge-lit slide rule scales provide effortless tuning. Styling features vinyl-clad steel cover in black with inlaid gold design and soft black, rigid die-cast panel set off by brushed gold trim, black knobs with gold inserts. Shpg. Wt. 24 lbs.

MODEL BC-1A

$26.95

HIGH FIDELITY AM TUNER KIT (BC-1A)

Delivers AM broadcast reception comparable to FM quality. Features a special detector using crystal diodes and broad-band IF circuits for low signal distortion. Prealigned RF and IF coils eliminate the need for special alignment equipment. Sensitivity better than 3 microvolts for one volt output. Two output levels provided. Built-in power supply. Special antenna supplied, also provision for outside antenna. Shpg. Wt. 9 lbs.



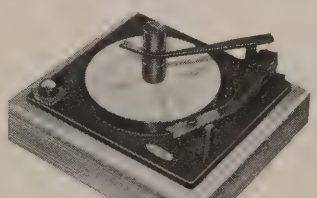
MODEL FM-3A

$26.95

HIGH FIDELITY FM TUNER KIT (FM-3A)

Featuring broad-banded circuits for full fidelity and better than 10 microvolt sensitivity for 20 db of quieting, the FM-3A pulls in stations with clarity and full volume. Incorporates stabilized temperature compensated oscillator, built-in power supply, pre-aligned IF transformers and ratio detector. The pre-assembled tuning unit is pre-aligned. Two output levels provided. Shpg. Wt. 8 lbs.

AUTOMATIC HI-FI RECORD CHANGER KIT (RP-3)



Combining automatic convenience with turntable quality through unique and simple design the Heathkit RP-3 handles your records with the finest of care for full fidelity reproduction. The unique "turntable pause" feature during change cycle and smooth friction clutch start prevents record damage. Proper weight distribution and low pivot point friction of the tone arm minimize arm resonance, tracking error, and record wear. All record changer kits come equipped with changer base, stylus pressure gauge, 45 RPM spindle, and necessary wire.

STEREO MODEL RP-3S: Equipped with Shure diamond stylus magnetic cartridge providing frequency response of ±4 db from 30 to 14,000 CPS. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3-LP: (monaural microgroove recordings only): Equipped with Fairchild Magnetic diamond stylus cartridge. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3: Features a GE VRII magnetic cartridge with diamond LP and sapphire 78 stylus. Shpg. Wt. 19 lbs. **$64.95**

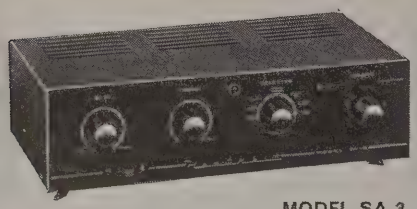
SPECIFICATIONS—Operates from: 105-130 volts 60 cycles. Wow and Flutter: Less than 0.18% peak at 33-1/3 RPM. Turntable Speed: Accurate within ±2%. Change Cycle: Completed in 9 seconds. Dimensions: 13¼" wide x 12" deep, 5" above and 3" below mounting board. Motor Type: 4 Pole hum shielded. Type of Drive: Friction. Record Speeds: 4 speeds. Automatic and manual 33-1/3, 45, 78 RPM. Manual only—16 RPM. Variations in Tracking Force: Less than 0.9 gram from first record to tenth record. Controls: "ON-OFF" switch, Manual Reject, "Speedminder" (automatic speed selection and indexing). Manual speed selector (4 speed). Finish: Midnight Gray. Base: Maple (unfinished). Mounting Board: Birch (unfinished).

NEW from the HEATHKIT AUDIO LABS

a complete line of monophonic and stereo

HEATHKIT®

Hi-Fi Amplifiers



MODEL SA-3

NEW **$29.95**

NEW "ECONOMY" STEREO AMPLIFIER KIT (SA-3)

The all-new Heathkit SA-3 Stereo Amplifier has all the convenience of complete dual channel control at a fraction of the cost of comparable equipment. High level preamplifier section of the SA-3 provides complete control for both channels. Ganged tone controls provide "boost" and "cut" for base and treble. Dual concentric volume controls make possible precise channel balancing. A channel reversing switch and a speaker phasing switch allows optimum performance. Two separate inputs are provided for each channel to accommodate ceramic cartridge phonographs, AM-FM tuners, or tape recorder. Program source may be reproduced in either monophonic or stereo form. A really big package of stereo performance for the small investment! Shpg. Wt. 13 lbs.

SPECIFICATIONS: Power Output: 3 watts per channel, Utility Rating. **Power Response:** ± 1 db 60 cps to 20 kc at 3 watts output. **Total Harmonic Distortion:** less than 3% 60 cps to 20 kc at 3 watts output. **Intermodulation Distortion:** less than 3% at 3 watts output using 60 cycle and 6 kc signal mixed 4:1. **Hum and Noise:** 65 db below full output. **Controls:** dual clutched volume, ganged treble, ganged bass, 7 position selector, speaker phasing switch, on-off switch. **Inputs:** (each channel) tuner, crystal or ceramic phono. **Outputs:** (each channel) 4, 8, and 16 ohms. **Finish:** black with gold trim. **Dimensions:** 12½" W. x 6¾" D. x 3¼" H.

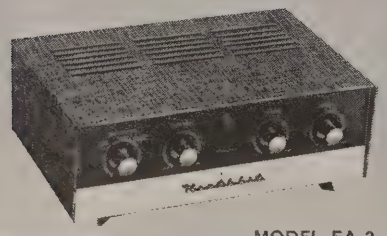
MODEL EA-1

NEW **$15.95**

NEW "ECONOMY" 3 WATT AMPLIFIER KIT (EA-1)

More than enough for room filling volume . . . ideal for getting started on a low cost individual component system. Designed for use with ceramic cartridge record players, tuners, tape recorders, etc. Built-in preamplifier provides you with all the necessary tone and volume controls for adjusting the sound reproduction to your personal taste. Smart appearance, quality components, assemble it in a few hours for years of trouble-free enjoyment. Shpg. Wt. 7 lbs.

SPECIFICATIONS: Power Output: 3 watts, Utility Rating. **Power Response:** ± 1 db 60 cps to 20 kc at 3 watts output. **Total Harmonic Distortion:** less than 3%, 60 cps to 20 kc at 3 watts output. **Intermodulation Distortion:** less than 3% at 3 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and Noise:** 70 db below full output. **Power Supply:** transformer operated full wave rectifier. **Inputs:** (2), crystal or ceramic phono cartridge, tuner. **Input Sensitivity:** 100 mv for 3 watts output. **Output Impedance:** 4, 8, and 16 ohms. **Dimensions:** 3¼" H. x 9½" W. x 6" D.



MODEL EA-3

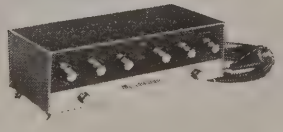
NEW **$29.95**

NEW 14-WATT HI-FI AMPLIFIER (EA-3)

From HEATHKIT audio labs comes an exciting new kit . . . New Styling, New Features, Brilliant Performance! Designed to function as the "heart" of your hi-fi system, the EA-3 combines the preamplifier and amplifier into one compact package. Providing a full 14 watts of high fidelity power, more than adequate for operating the average system, the EA-3 provides all the controls necessary for precise blending of musical reproduction to your individual taste. Clearly marked controls give you finger-tip command of bass and treble "boost" and "cut" action, switch selection of three separate inputs, "on-off" and volume control. A hum balance control is also provided,

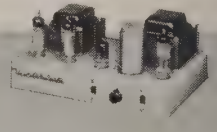
NOTE THESE OUTSTANDING SPECIFICATIONS: Power Output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts, Utility. **Power Response:** ± 1 db from 20 cps to 20 kc at 14 watts output. **Total Harmonic Distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation Distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and Noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts.

PREAMPLIFIERS



Model WA-P2 "Master Control" hi-fi preamplifier kit. 7 lbs. **$19.75**
Model SP-2 Mono-Stereo (2 channel mixer) Preamplifier kit. 15 lbs. **$56.95**
Model SP-1 Single Channel version of SP-2. 13 lbs. **$37.95**
Model C-SP-1 Converts SP-1 to SP-2. 5 lbs. **$21.95**

POWER AMPLIFIERS



Model UA-1 "Universal" hi-fi 12-watt amplifier kit. 13 lbs. **$21.95**
Model W-4AM Single Chassis 20-watt hi-fi amplifier kit. 28 lbs. **$39.75**
Model W-3AM Dual Chassis hi-fi 20-watt amplifier kit. 29 lbs. **$49.75**
Model W-7M "Extra Performance" hi-fi 55-watt amplifier kit. 28 lbs. **$54.95**
Model W-5M high fidelity 25-watt amplifier kit. 31 lbs. **$59.75**
Model W-6M high fidelity 70-watt amplifier kit. 52 lbs. **$109.95**

SPEAKER SYSTEMS

Model SS-3 "Basic" fir hi-fi speaker system kit. 26 lbs. **$34.95**
Model SS-2 "Basic Range" hi-fi speaker system kit. 26 lbs. **$39.95**
Model SS-1B "Range Extending" hi-fi speaker system kit. 80 lbs. **$99.95**

Model HH-1 "Legato" hi-fi speaker system kit. 195 lbs. **$299.95**

HEATHKIT®

HEATH COMPANY, Benton Harbor, Michigan

a subsidiary of Daystrom, Inc.

NEW: Heath Now Puts 2-Way Radiotelephone Communications in Reach of Everyone

Citizen's Band Transceiver Kit

NEW: No Radio Operators License Necessary!

NEW from the HEATHKIT COMMUNICATIONS LABORATORIES

- Designed to meet all FCC requirements for new 11-meter "Citizens Band" class D operation.
- Any U.S. citizen 18 or older eligible for license.
- No theory to study—no tests to take.
- Hundreds of uses in business or pleasure.
- Top quality components—proven performance—easy to build.

SPECIFY FREQUENCY CHOICE

CLASS D CITIZEN'S BAND FREQUENCIES

26.965 mc	27.035 mc	27.115 mc	27.185 mc
26.975 mc	27.055 mc	27.125 mc	27.205 mc
26.985 mc	27.065 mc	27.135 mc	27.215 mc
27.005 mc	27.075 mc	27.155 mc	27.225 mc
27.015 mc	27.085 mc	27.165 mc	*27.255 mc
27.025 mc	27.105 mc	27.175 mc	

*This channel shared with Class C Radio Control.

NEW

MODEL CB-1

Includes transceiver, microphone, and special power cords.

$42.95

First and only kit of its kind . . . designed to meet all FCC requirements for two-way radio telephone communication on new class D 11-meter "citizens band" . . . any U.S. citizen eighteen or older eligible for license . . . no code test, no radio theory exams, no knowledge of specialized operating procedures required . . . just fill out simple form included with kit and mail to FCC for registration. The Heathkit CB-1 Transceiver is light, compact, simple to assemble, easy to use. Buy two or more units, have your own communications system . . . talk with family, friends, associates from your car, home, boat or office . . . cover distances from one to ten miles depending on location and type of installation (extensively field tested). A flick of a switch selects "transmit" or "receive" while single receiver tuning control selects any of 23 assigned channels . . . third knob controls volume and turns set on and off. With separate vibrator power supply available from Heath, along with two special power cords included with kit, you can convert transceiver from fixed location at home or office to mobile operation in cars, boats, etc., in minutes, after initial installation, with no tools or adjustments. There's a Heathkit accessory antenna for any application, mobile or fixed. Kit comes complete with microphone, station identification card which fits in plastic window at end of cabinet, all pertinent FCC regulations and application forms, a sheet of adhesive-back letters and numbers to affix call letters in space provided on front panel, and crystal for one channel. Specify your frequency choice or we will supply crystal of appropriate frequency. The famous Heathkit quality coupled with the market-shattering low price of this kit make it truly a value of a lifetime. Shpg. Wt. 10 lbs.

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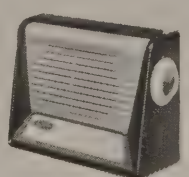

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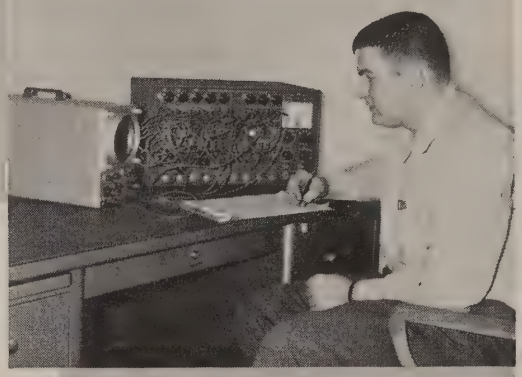

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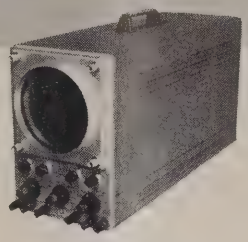

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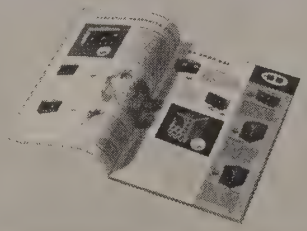

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ABC's of MOBILE RADIO

Part VII—Fixed stations: Let's see how their transmitters, receivers, power supplies are set up

By LEO G. SANDS

Electronic communications control console is used for railroad operations.

A BASE station is a land station used primarily for communicating with mobile units. A *fixed* station, a term often erroneously applied to base stations, is a land station used primarily for communicating with other fixed stations.

A typical mobile radio system has one base station and a number of mobile units. More elaborate systems may include two or several base stations. The Erie Railroad, for example, has a string of base stations stretching from Chicago to New York to provide complete coverage of the entire main line.

When a base station's radio equipment is located in the same room as the person who operates it, the station is known as a *locally controlled* station. When the operator and the radio equipment are in different rooms or buildings, the station is said to be *remotely controlled.*

There is only one legal control point, whether the station is locally or remotely controlled. The person at that point who is in charge of operating the radio station is responsible for the proper operation of the base station *as well as of the associated mobile units.*

Both types of stations may have one or more auxiliary control points known as *dispatch points.* These must be so wired that the operator at the *control point* can prevent use of the transmitter from any of the dispatch points if he deems it necessary.

Types of stations

A locally controlled base station ordinarily consists of a transmitter, receiver, power supply, antenna system, microphone, loudspeaker and controls. A typical locally controlled one is a consolette mounted on a desk, which houses all of the equipment except the antenna system and the microphone.

Sometimes the transmitter–receiver–power-supply assembly is placed in a relay rack or cabinet. Often a separate control unit is connected to the radio equipment through a multiconductor cable.

Sometimes the base station is identical to a mobile unit. The Kaar TR-500, for example, may be used interchangeably as a base station or as a mobile unit since it will operate from either 12 volts dc or 117 volts ac.

The radio equipment of a remotely controlled base station is similar to that used at locally controlled stations. Basically, equipment requirements are the same except for additional apparatus which lets the operator control the transmitter-receiver from a remote location.

The radio equipment is often mounted in a floor or wall mounting cabinet which can be locked to prevent tampering by unauthorized personnel. Control is exercised from a remote-control unit through a single-pair telephone line.

Operation is essentially the same as for mobile units (described in Part III of this series—April 1959). Communication takes place in one direction at a time. When transmitting, the operator uses a press-to-talk button which disables the receiver and causes the transmitter to go on the air. Releasing the button reactivates the receiver and shuts off the transmitter. Hence, only one antenna system is required when transmission and reception take place in the same band.

Transmitters

Medium- and low-power transmitters used at base stations are identical electrically (or very similar) to those used in mobile units. Sometimes the transmitter is assembled on a panel which fits into a standard 19-inch relay rack.

Generally, base-station transmitter rf output runs from under 1 watt to 60 watts. Sometimes, for extended coverage, and when permitted by FCC regulations, transmitters rated up to 250 watts are used. A 250-watt transmitter generally consists of a low-power FM transmitter which drives a 250-watt power amplifier. A heavy-duty power supply is usually provided for the power-output stage.

A single transmitter may be used on one, two or more channels. Frequency changing is handled by switching crystals or oscillator circuits. The spread between frequencies must, of course, be restricted since the various stages must be tuned to a compromise to provide adequate performance at all of the frequencies used.

Sometimes, in multichannel operation, separate transmitters are used for each frequency or pair of frequencies, using a common antenna with switching or individual antennas for each transmitter.

An FM transmitter is modulated in one of the early low-power stages, and adding an rf booster amplifier does not require any changes in the modulator and speech amplifier system.

AM transmitters are used in radio paging systems operated at 25 to 55 mc, in two-way systems operated in the 152–162-mc band and at medium frequencies (1.8–8.0 mc) and at airports for Unicom and airport advisory applications in the 180–134-mc band. AM is also used in some low-power industrial systems operated in the 25–50-mc and 152–162-mc bands as well as by class-B (465-mc) and class-D (27-mc) Citizens' radio stations.

The modulator system of an AM transmitter becomes more expensive as power increases since the final rf stage is usually modulated, rather than one of the low-power stages.

AM modulators

Remember when servicing AM transmitters that the modulation transformer is a critical component which, when operated improperly can contribute distortion and loss of efficiency.

Fig. 1 is a typical modulator circuit. Its frequency response and performance depend upon the values of C1, C2 and C3. Ordinarily, these components are selected at the factory to match modulation transformer T1.

If T1 is ever replaced it may be necessary to change the value of C2, and sometimes even C1 and C3. Capacitor

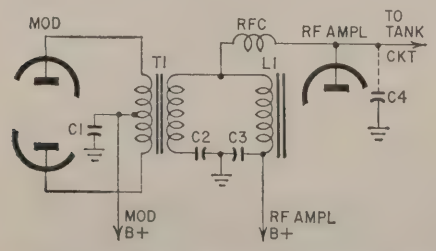

Fig. 1—Typical modulator circuit used in AM transmitters.

C2 is an audio coupling capacitor which prevents dc from flowing through the secondary of T1. Its value is critical and must compensate for T1's leakage inductance, which varies from one transmitter to another. The value of C2 affects the transmitter's low-frequency performance, which is important when low-frequency tones are used for selective calling or tone-squelch operation in communications transmitters.

Bypass capacitor C1 must also have a specific value, not just have of high enough capacitance to bypass the audio signal. C3 is also critical and its value must balance out the reactance of choke L1 at the low-frequency end of the modulation band.

High-frequency response is affected by the capacitance to ground (C4) of the rf amplifier and to some extent by the inductance of the rf choke. At the low-frequency end of the transmitter's rf range, there is generally more capacitance to ground than at the high end, due to the setting of the tuning capacitors. This effect is, of course, of considerably more significance in broadcast transmitters than communications transmitters where the audio response cuts off rapidly above 3,000 cycles.

Receivers

Base-station receivers are electrically identical (or at least similar) to mobile units. These fixed receivers are often assembled on panels which fit standard 19-inch relay racks.

In multichannel systems, it is often preferable to use a separate receiver for each channel, each with its own antenna, or multiplexed into a common antenna, so all channels can be monitored simultaneously. A way to mute any of the receivers from the control point when necessary is sometimes included.

When a single receiver is used for two or more channels, frequency change is handled by switching crystals or oscillator circuits, depending upon the technique used by the manufacturer.

Power Supply

Sometimes, as in mobile units, a common power supply serves both the transmitter and the receiver. Since more space is available at base stations, separate power supplies are sometimes used.

The performance of both the transmitter and receiver can be adversely affected by large variations in input voltage. These effects can be counteracted by installing a voltage regulator such as a Sola transformer or a Curtiss-Wright ac voltage regulator, which compensate for wide variations in line voltage and load. They are often well worth their cost in increased tube life alone, let alone improved performance.

A communications system has no value if it is not working. Power failure can disable a base station, and usually happens when communication is most urgently needed.

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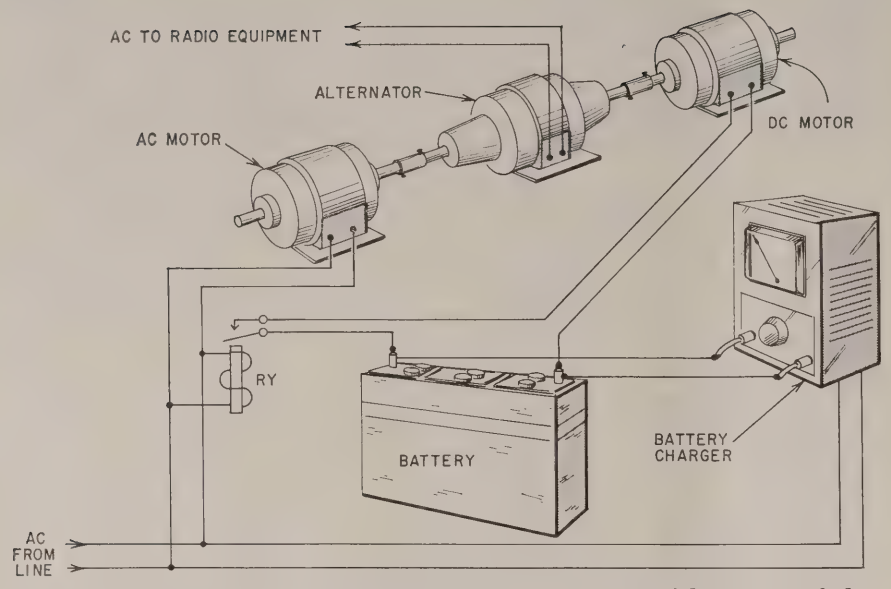


Fig. 2—Power supply provides continuous ac power even if line power fails.

A gasoline-engine-driven alternator with an automatic starter is a good standby power source. The standby generator takes over in case of power failure, shutting itself off when utility power is restored.

In some cases continuity of operation is so important that the time required for a gasoline engine to start cannot be tolerated. A battery bank and a vibrator type converter may be used as a standby power source. Delay is then only momentary since the vibrator starts functioning as soon as the changeover relay applies power to it.

Continuous power, with no interruption at all, can be provided by a continuous power generator, such as those developed by Bogue Electric Manufacturing Co. This consists of an ac motor, ac generator and a dc motor coupled as shown in Fig. 2.

The radio equipment always receives its power from the ac generator, which is ordinarily driven by the ac motor. When utility power fails, relay RY is de-energized and its contacts connect the dc motor to the battery. This happens so quickly that no power interruption occurs. When power is restored, relay RY is energized and cuts off the battery. The battery is kept charged by a battery charger, powered from the ac line.

Controls

Control of a transmitter–receiver combination may be extended by lengthening the leads from the microphone, loudspeaker, press-to-talk switch and frequency-selector switch (when used) to the radio equipment. As many as 11 conductors are required, and the two microphone leads should be shielded. Separation between radio equipment and control point is obviously limited because of the losses in the lines as well as by the possibility of hum pickup by the microphone leads. When the control point is a significant distance away from the transmitter, a remote-control unit which lets the operator control the radio station over a single-pair telephone line is preferred.

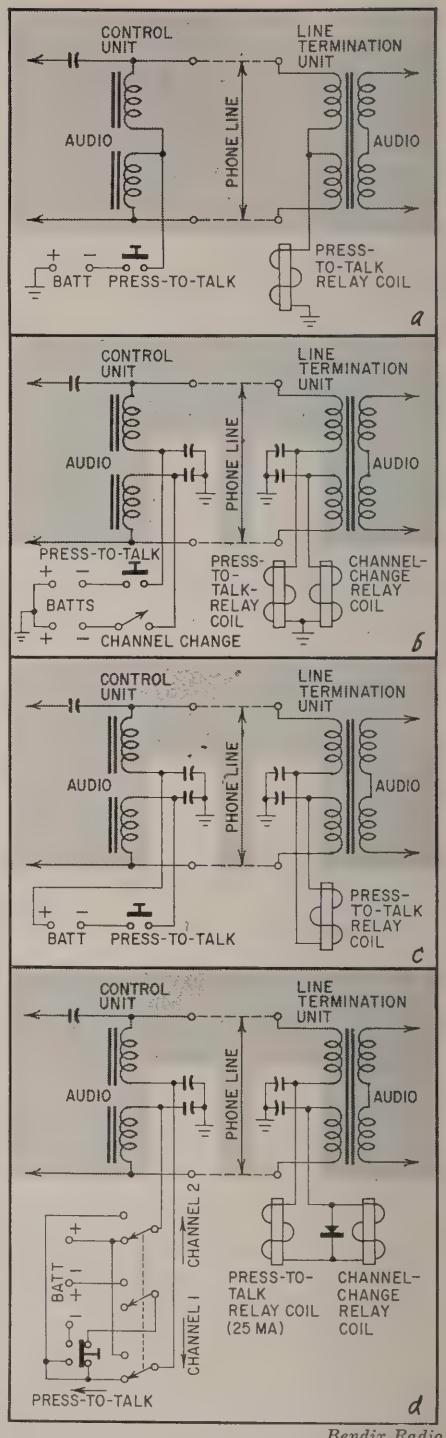


Fig. 3—Four methods for remote control over a single pair of lines: a—simplex; b—composite (two-function simplex); c—metallic loop; d—metallic loop, current differential.

Bendix Radio

Fig. 3 shows four popular methods for remote control over a single pair. In Fig. 3-a, the circuit is simplexed to ground. When the press-to-talk switch is closed, dc flows through both line chokes, both legs of the line, both halves of the line transformer of the line termination unit and through the relay coil to ground and back to the line control-voltage source (shown as a battery for simplicity).

In Fig. 3-b, two functions are performed. The line is split by capacitors at each end, preserving the ac relationship but dividing the line into two dc circuits. When the press-to-talk button is closed, dc flows through one choke, one side of the line, one winding of the line transformer at the far end, through the relay coil and back to the control point through ground. When the channel-change switch is closed, the same thing happens through the other side of the circuit. Either or both circuits can be operated, sequentially or simultaneously.

Dependence upon ground as a return circuit can be avoided by using the circuit shown in Fig. 3-c. Here, when the press-to-talk button is closed, dc flows through one choke, one side of the line, one half of the line transformer primary, the relay coil and back through the other half of the line transformer primary, the other side of the line and the other choke to the press-to-talk switch.

The circuit shown in Fig. 3-d is used to control two functions without requiring ground as a return circuit. When set in channel 1 position and when the press-to-talk button is closed, current flows through the coil of the press-to-talk relay at the far end but is bypassed around the coil of the channel-change relay by the rectifier.

When set for channel 2, the polarity of the energizing power source is reversed. Now both relay coils are energized since the rectifier across the channel-change relay coil opposes the flow of current, which must now flow through the coil instead of around it.

Fig. 4 is the circuit of a Bendix MS-289B line termination unit. Transformer T101 is the line transformer shown in Fig. 3. When relay K101 is energized, the secondary of the line transformer is switched from the receiver's audio output to the trans-

mitter's microphone input. Another pair of contacts closes the circuit which controls the relays that disable the receiver and energize the transmitter.

The fixed pad consisting of R106, R107, R108 and R109 attenuates the audio signal level to approximately 0 db. However, it does not load the receiver output and, unless a speaker is connected to the receiver, a resistive load should be added. T-pad R101 permits setting the audio input level to the transmitter to the desired level.

For two-channel operation, relay K102 is added. When energized, it closes the circuit controlling the frequency-change relay.

Fig. 5 is a block diagram of one type of remote control unit. When relay RY is energized by closing the press-to-talk switch, the line transformer is disconnected from the input of the *receive* amplifier and connected to the output of the *transmit* amplifier. Another pair of contacts applies dc to the center tap of the line transformer. This energizes a relay at the far end, switching the remote station to receive.

Most remote-control units are designed for use with radio equipment of the same make. Others are designed for use with any make of radio equipment.

The complete Kaar 117C903 remote-control system consists of a remote control unit and a switching-line amplifier plus a dynamic microphone with desk stand. This system makes it possible to select any one of three transmitters or channels, switch line power to the base station on or off, and adjust the squelch setting of a remote receiver as well as amplify audio in either direction and reproduce the audio signal from the distant receiver, all over the same pair of wires.

The switching-line amplifier, which fits into a standard 19-inch relay rack, is installed at the radio station adjacent to the transmitter(s) and receiver. Its amplifier provides up to 40 db of gain of audio signals from the remote control and dispatch points and delivers up to 12 db above 6 mw.

The remote-control unit, which is obviously installed at the control point as well as at additional dispatch points, delivers up to 14 db above 6 mw to the line. The output is generally set at 0 db equals 6 mw. An automatic gain control compensates for microphone output variations up to 20 db. The input signal from the base-station receiver may be as low as —20 db equals 6 mw for a full 1-watt rated output to the built-in speaker or 0.8 watt each to the built-in speaker and one external speaker. This control system is intended for use with lines up to 20 miles long.

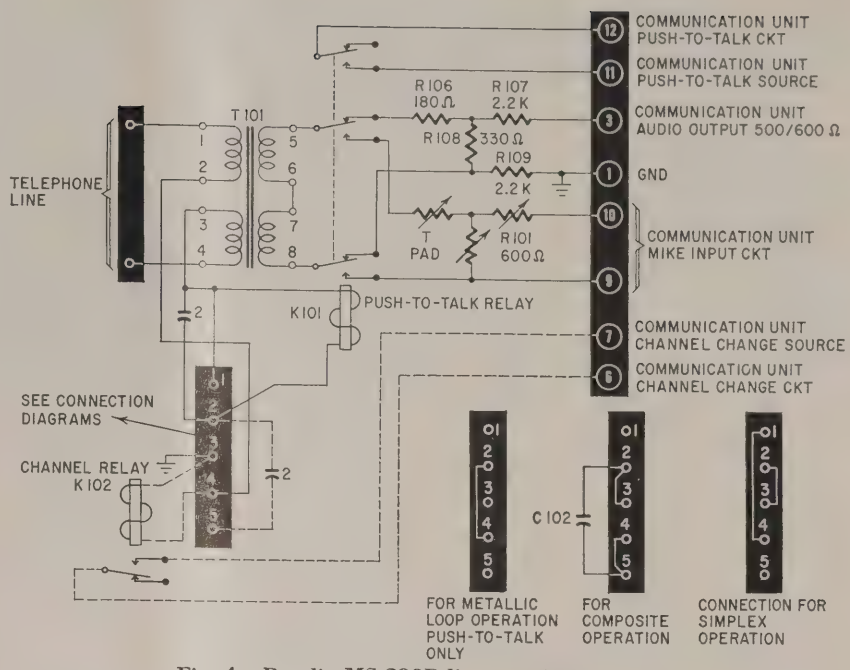


Fig. 4—Bendix MS-289B line-termination unit.

The multiple control functions are taken care of by applying different positive dc voltages to one or both sides of the telephone line. At the base-station end of the line, the dc is applied to one or more relays in the switching-line amplifier. These various relays pull in at different currents and hence can be energized selectively.

A unique feature of this remote-control unit is its ability to control the squelch of a distant receiver. The simplified schematic in Fig. 6 shows how this is done. In "receive" condition when relay RY1 is de-energized, a negative voltage (adjustable from 0 to 20) is applied to line 1 through one winding of T1. At the far end, this voltage is fed to the receiver squelch which is controlled by adjustment of R1. This low voltage does not affect relay RY2.

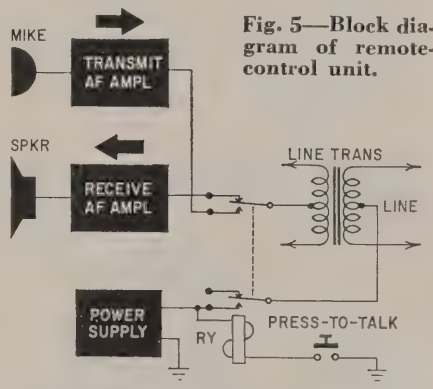
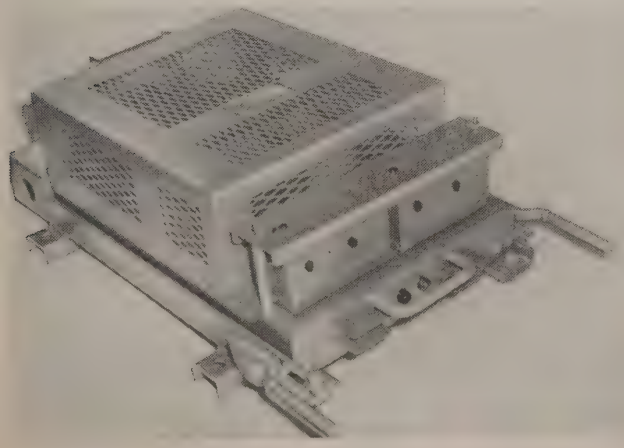


Fig. 5—Block diagram of remote-control unit.

When press-to-talk switch S1 is closed, relay RY1 is energized and a positive 105 volts dc is applied to the line. This forces enough current through relay RY2's coil to energize it and turn on the transmitter.

Next month we will look into another remote-control system. Then a brief study of antennas, transmission lines, relay stations and Conelrad will bring this series to an end. TO BE CONTINUED



Vibrator type converter used with storage battery forms a standby ac power supply for a base station. A Cornell-Dubilier unit.

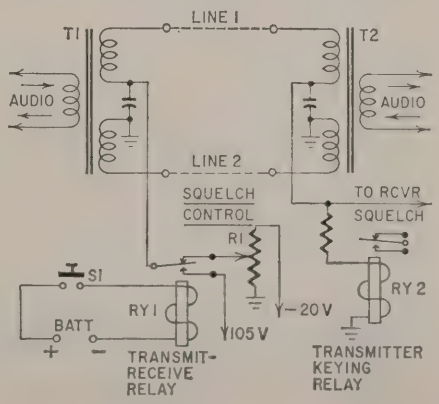


Fig. 6—Simplified schematic shows how squelch is controlled remotely.

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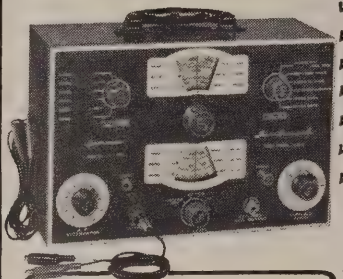

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This Versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

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The Model TV-50A comes complete with shielded leads and operating instructions. Only **$47.50**

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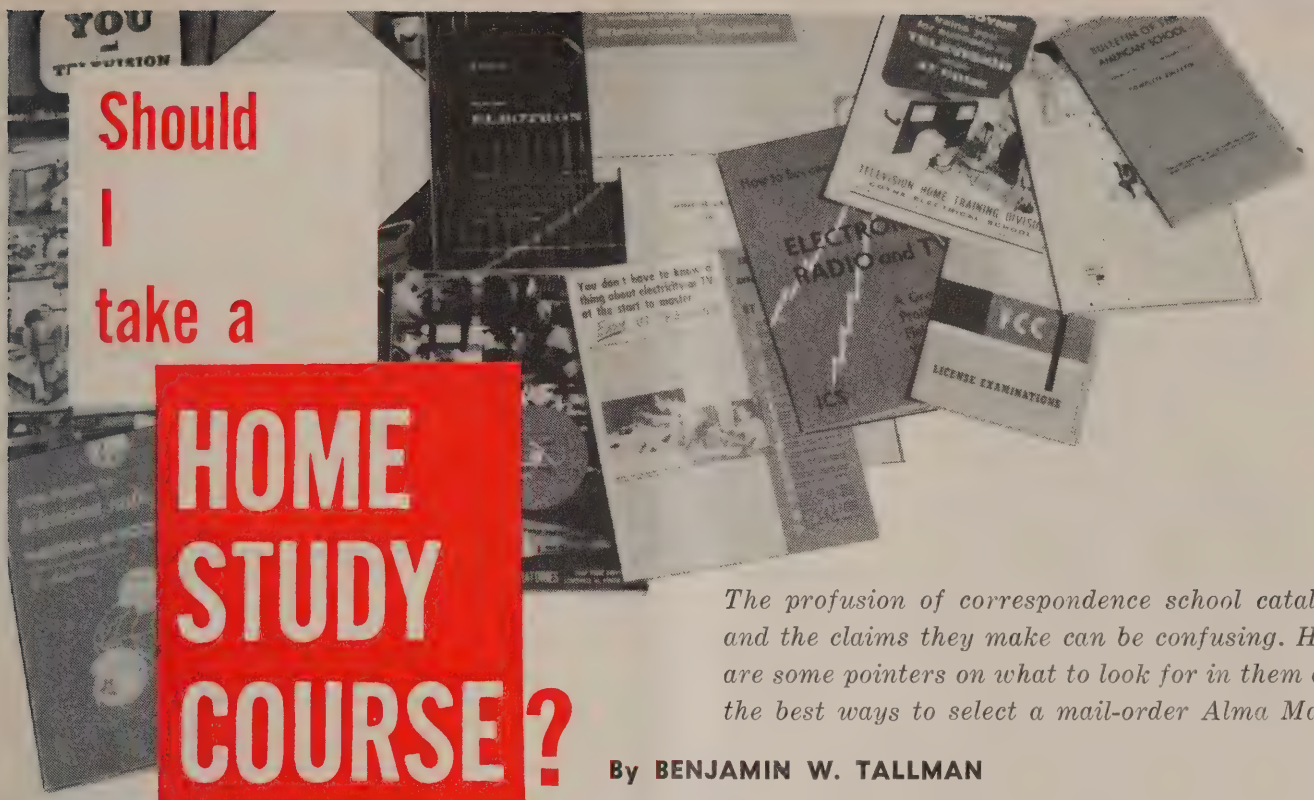


Should I take a HOME STUDY COURSE?

The profusion of correspondence school catalogs and the claims they make can be confusing. Here are some pointers on what to look for in them and the best ways to select a mail-order Alma Mater

By BENJAMIN W. TALLMAN

GOING to school by mail" is an accepted and respected method of getting a general or specialized education. More people enroll in so-called "correspondence schools" or "home study schools" every year than in all the colleges and universities combined.

In the electronics field about three dozen national institutions offer home study courses, all the way from basic radio to advanced electronic engineering—and more home study students enroll in radio-television-electronics than in any other subjects.

Should you take a home study course? If so, how do you go about choosing the right course and the right school?

First, it's important to bear in mind that a home study course is necessarily only a substitute for "resident" or classroom–lab study. It's true that you *can* get as good an education studying at home as in the classroom—but don't kid yourself, it's going to be more difficult.

This is because your only contact with your instructors and your school will be through the United States Post Office. Therefore, it's going to require a greater expenditure of time and much more self-discipline to learn a given amount studying at home, as compared with the day-to-day personal contacts with instructors and fellow students in a resident school.

Home study schools came into being to fill the educational needs of people who lived too far from classroom type schools or whose hours of work made it impossible for them to attend "live" classes.

If you live in an area served by a good electronics school and can arrange your time so you can take a day or evening course with personal instruction, you would be wise at least to investigate this alternative to home study. Though it's often more expensive than mail-order schooling, it's usually well worth the difference. Some good schools offer both home study and resident training in various aspects of electronics.

Home study schools do, however, have a couple of big advantages over resident schools: You progress at your own pace; you arrange your own study hours; you can "attend" a good school in a distant city offering training which might not be available in your own area.

How much like a classroom?

No one has ever really improved on the classroom-and-lab technique of teaching. So in evaluating a home study course you'll want to ask yourself: How closely does this resemble classroom teaching?

When you consider that most TV–radio correspondence courses cost from $100 to $450, you'll want more than a mere textbook or set of books. You can learn by reading a $15 textbook, but you can learn better and quicker from a textbook plus personalized instruction plus lab work.

If you become a home study student, you will receive one group of lessons at a time by mail (plus kits of lab parts, if they're included in the course). At the end of each lesson is a series of examination questions to determine how well you have absorbed the material in the lesson. You must send the completed examinations to the school for grading before another set of lessons is mailed to you.

So far so good. Just like a classroom school. But in a classroom school there's one big advantage—you can ask questions. Most good home study schools give you the same privilege—again through Uncle Sam's Post Office.

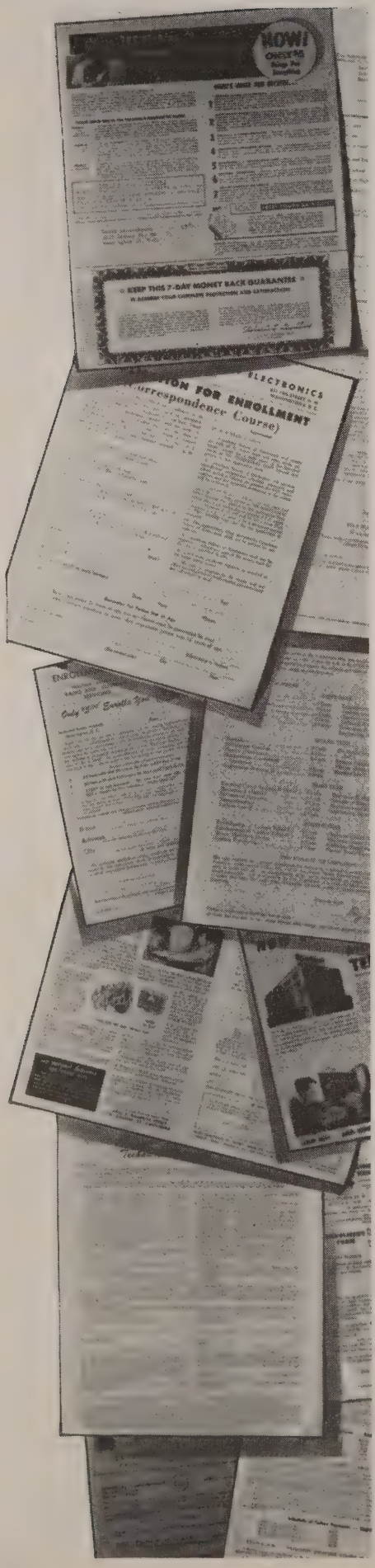
Good correspondence schools permit students to ask an unlimited number of questions about things they don't understand. Some extend this "consultation" service for a year or more after the course is completed, while the graduate is getting himself established in the electronics field.

Of course, you pay for this individualized service—and if you're interested in just a brushup course without it, there are schools offering training at a lower cost minus this elaborate personal service. But now we're back to the "textbook" approach, and an alternative might be to buy a couple of reliable up-to-date books.

Kits and lab work

In addition to "lectures" (lesson books) and "personal instruction" (mail query service), many electronics home study courses have "lab" programs—indeed, they should have in such practical courses as TV–radio servicing. Be on your guard when a school claims you need no equipment to study electronics. It is mighty difficult to learn about circuits without actually having one to trace as you read the printed lesson material.

Some of the home training programs supply the required laboratory equipment in kit form. Others rely on the student to buy the needed parts locally. The school that includes equipment will, of course, charge considerably more for its program—but you are assured that the equipment you use in training will follow the diagrams and instructions in the textbooks. However, under certain circumstances you may be able to save a little on the cost of your equipment



by buying parts "on the outside."

A few schools offer their home study graduates several weeks of resident instruction at no extra cost or for a small additional fee. This is mostly lab work and is well worth considering if it is at all possible for you to be away from your home and job for the required time. This resident instruction privilege might be the deciding factor in your choice of a school if the location of the resident training is accessible and you can afford to take a couple of weeks off.

Home study schools offer a large number of "fringe benefits" as inducements to prospective students. Among these are fancy diplomas, job placement services, references to prospective employers and so forth.

Nearly every school will do something about helping you get a job. Some have elaborate employment bureaus and job counseling service. Others merely write letters of reference to prospective employers whose names you send them.

Don't be dazzled by these extra services. Remember, the value of the course lies in what you learn. If you know your stuff, it will be relatively easy to land and hold a job in your chosen field. But if you don't, an engraved diploma and a fancy employment service won't conceal that fact from your boss.

Types of courses

A wide variety of home study courses is offered in the electronics field. The most popular are the basic radio–TV–electronics courses which start with the assumption that you don't know an electron from a kilowatt and work up through TV troubleshooting and repair. Even if you have a basic grounding in electronics, this is the course to take if you want to learn TV–radio servicing or to improve your skills as a technician. Other basic courses include the communications field and prepare the student for a first-class radiotelephone or radiotelegraph license. This license is a Federal government requirement for technicians working in TV or radio stations, mobile, shipboard radio and other fields where transmitters are involved as well as receivers.

Several schools offer advanced training—that is, the program is designed for the man who already has extensive experience in electronics. If you have the training, they can teach even the oldest dog a few new tricks. If you lack the know-how, be sure the school you select offers training for the novice.

To take the advanced courses—which generally include mathematics as part of the curriculum—the schools require you to have had either specific training or its equivalent in practical experience.

Some home study schools operate like engineering colleges—that is, they offer a large choice of subjects, permitting the student to take as many as a half-dozen at a time. Some have a full 4-year program.

But be wary of the school that offers a degree by mail. Most state laws prohibit the awarding of degrees for correspondence work.

The contract, whether it's called "Enrollment Blank" or "Application for Admission," is binding upon you and the school, and outlines the rights and obligations of both parties.

What about prices?

The cost of home study training varies all over the map. Radio–TV–electronics technician courses range from about $140 to $450, with equipment kits. Without kits, they start at $40 and go up to about $200, depending on the school. Generally the schools which cost more offer the student more individualized instruction, better equipment and better lesson materials than the cheaper ones. If you want good training, watch out for the real cheapies—investigate them thoroughly before you even think of signing on the dotted line. The old saw, "You usually get what you pay for," generally holds true in the correspondence school field.

All home study schools have "pay-while-you-learn" plans—or in simple English, time payments. The down payment ranges from $5 to $100, with monthly payments from $6 to $50, depending on the school and course. If you choose to pay cash, or to pay your tuition in full in 2 to 6 months, you save from 6% to 15% of the installment plan cost.

There are some advantages to paying on the installment plan, even if you have the cash. For example, if you find it necessary to drop the course without completing it, in some cases it may take a long time to get a partial refund after you have paid your full tuition.

If you do drop a course, you won't get a refund of what the school calls the "matriculation fee" (usually about 15–20% of the entire cost). You also must pay so much for each lesson completed. Although a few schools stipulate in their contracts you must pay for the entire program if you drop the course, this is rarely legally enforceable.

Several schools charge on a per-lesson or lesson-group basis—a specified amount for each group of lessons or kit of parts, rather than on a flat-fee basis for the entire course.

You proceed with your lessons at your own pace in home study. Schools allow you to advance as fast as you wish and give you a maximum of 2½-3 years to complete the course—plenty of time for anybody who is the least bit serious about his studies.

About the GI bill

If you are a veteran, the Government will pay for certain home study courses, provided you enroll within 3 years after your discharge from military service. Some two dozen electronics courses offered by 10 correspondence schools are certified under the "Korean GI bill."

The schools with GI-certified courses aren't necessarily better than the others—certification merely means that the courses meet certain standards and the schools have agreed to abide by

specific Government bookkeeping and billing procedures.

If you take your home study training under the GI bill, you still pay your tuition directly to the school out of your own pocket. Every 3 months you receive a check from the Veterans Administration on the basis of the number of lessons you have completed, at so much per lesson. When you have successfully completed your training, you will have been repaid approximately the cost of your tuition.

As a matter of fact, some schools let the veteran defer his payments until the Government check arrives. Your local VA office can give you a list of schools offering electronics home training under the GI bill.

How to get going

Bearing all these things in mind, you are now ready to choose the particular course and school which is best for you.

Unfortunately, here you may be buying a pig in a poke if you don't proceed carefully. There is no universally accepted accrediting organization for home study schools as there is in the field of college education.

One organization, the National Home Study Council (NHSC), has undertaken an accreditation program, and its list, which currently includes 10 schools offering electronics courses, is available from the council at 1420 New York Ave., Washington 5, D. C.

While the NHSC-accredited schools are required to adhere to certain codes of ethics, educational standards, reasonable prices and truth in advertising, a large number of excellent schools of unimpeachable reputation are not members and have never applied for membership.

There are two other groups which accredit both resident and home study schools: the Engineers Council for Professional Development (ECPD), which approves engineering courses only, and the National Council of Technical Schools (NCTS).

After you have decided what type of course you want to take—basic servicing, communications, engineering, math, color TV, etc.—your best bet is to write to as many schools as possible and ask for information.

Most of the schools advertise in magazines dealing with the electronics field. You will have no trouble compiling a list from the advertisements, or you may want to select from the list printed here as a starter. Then write—and wait for the barrage!

Schools answer their mail quickly, usually sending out a catalog and other form literature the day the request is received and dispatching a personal answer to your questions later.

Reading the catalog in the light of the points already mentioned will reveal to you a great deal about the school and its training. It should tell you what the course will cover (usually with a list of lessons and the subjects they include), the extent of personal query-answering service, the qualifications of the instructors, the equipment supplied, tuition costs, time payment plans, the placement or job reference program, etc.

(Some school catalogs leave much to be desired. Of 13 home-study school catalogs examined in the preparation of this article, 6 didn't have any specific reference to the qualifications of their instructors and 2 didn't contain a list or summary of lessons and kits included in the course.)

The catalog should tell or show you the answers to these questions about the "personalized" aspect of the course: Does the school have complete and thorough exams at the completion of each phase of training? Are they promptly graded and returned? If you fail to answer a question correctly, do the instructors tell what you did wrong or do they just mark it incorrect and let it go at that? Can you get unlimited personal answers to questions that come up during the course of your studies or lab work?

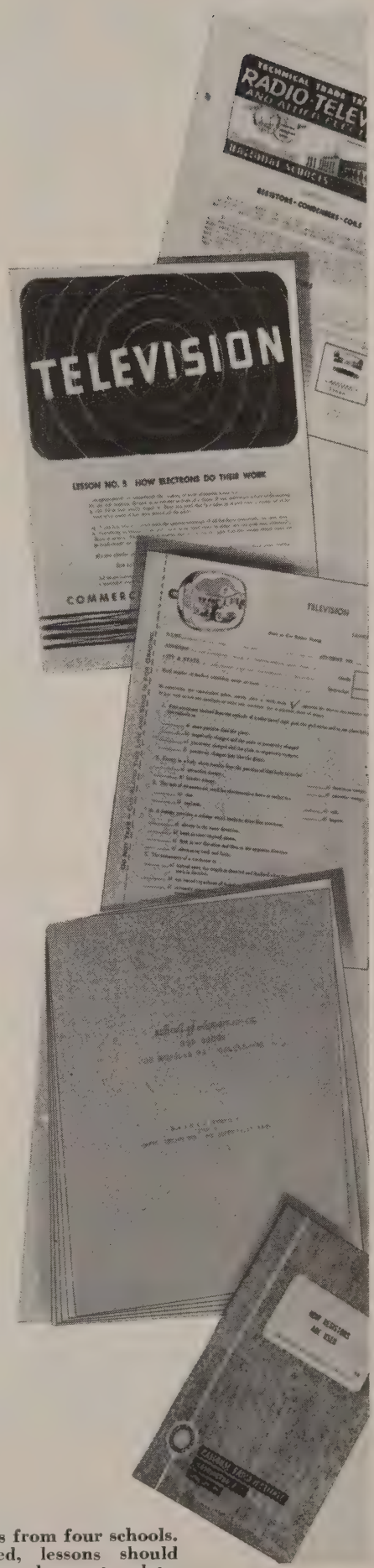
It's a good idea to ask for a sample lesson—no school that has something to offer should be reluctant to let you see one of its lessons. Some schools have a standard "sample lesson" which may be longer or more profusely illustrated than the regular lessons sent to students.

To avoid receiving a specially doctored "sample lesson," you can ask for a specific one by number. For example, we asked 24 electronic home study schools to send us Lesson No. 5 in their basic TV–radio course. Only 4 of them did, but those lessons we received told us a great deal about the value of the instruction.

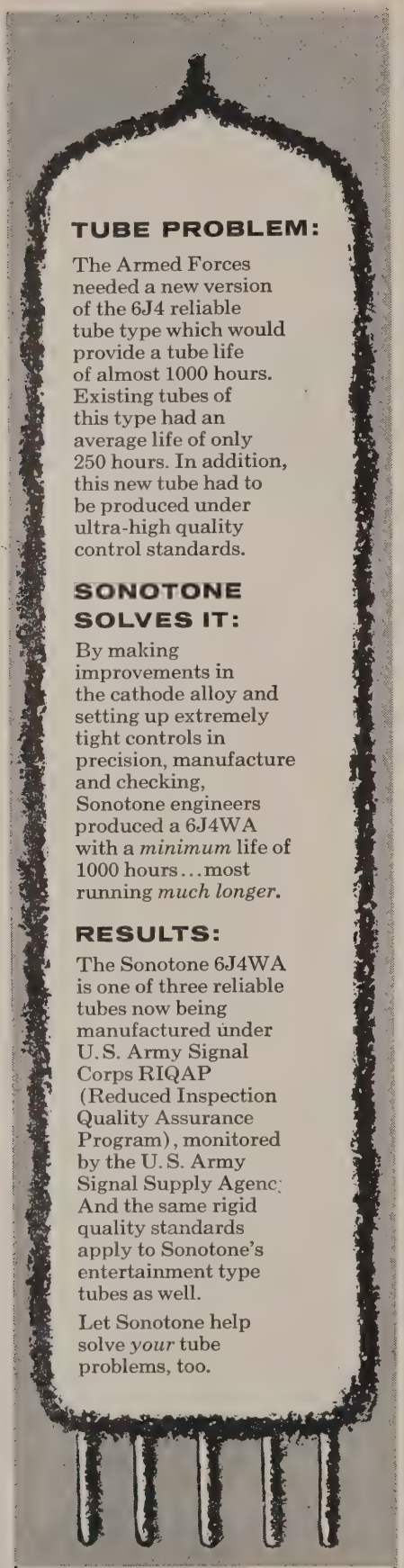
If you receive sample lessons, look them over carefully. Do they seem old and outdated? Do they have enough illustrations to demonstrate the lessons clearly? Is each individual subject fully treated and completely covered? Are the examination questions at the end of each lesson concise, clear and comprehensive? If you know an electronic technician or engineer, ask him to look over the sample lessons and give his opinion of the value of the material.

Another way to check on a school is to talk to its former students. Any reliable school will be happy to furnish the names and addresses of recent graduates in your area on request. Talk to these men and get their opinions of the quality of the instruction, the way the student is treated, the staff, etc.

Several of the schools employ "representatives"—a fancy word for salesmen—and if you write to a group of home study schools, you most certainly will be contacted by some of them. While they can be helpful in answering your questions, they can and do sometimes make promises which the school is not obligated to keep. Put your



Typical home study lessons from four schools. Mimeographed or printed, lessons should be easy to understand and up to date.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dependence not on word-of-mouth claims but only on what is backed up in writing in the contract and catalog of the school.

Remember, the school is legally required to live up to the statements in its catalog, but not to statements made by its salesmen.

The contract

When you finally enroll in a home study school, you'll sign a contract (usually called "Enrollment Blank" or "Application for Enrollment") which defines your rights and obligations and the school's responsibilities. Read it carefully.

The entire school catalog is actually "part of the contract," since the contract specifically binds the school to perform the services "as described in the current catalog" or "as described in the school literature" or some similar phrase. If you have any questions about the contract, write to the school before signing it—and save the reply you receive, in case you have to refer to it later.

After you begin your training, if you feel that the school's courses or contract have been misrepresented in its advertisements or literature, send complete details to the Federal Trade Commission, Washington 25, D. C. This probably won't help you personally, but it may prevent the school from deceiving future enrollees.

Home study schools are carefully policed by federal and state governments, and deceptive ads and wild claims are far less of a menace than they were a generation ago.

As you read this, more than 1,500,000 people in the United States are getting training by mail. Many highly successful electronic technicians and engineers received all or most of their technical training through home study.

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412 5th St., N. W.
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Capitol Radio Engineering Institute
3224 16th St., N. W.
Washington 10, D. C.

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1644 Wyandotte St.
Kansas City 8, Mo.

Cleveland Institute of Radio Electronics
4900 Euclid Ave.
Cleveland 3, Ohio

Chicago Vocational Training Corp.
3330 University Ave., S. E.
Minneapolis, Minn.

Christy Trades School, Inc.
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Chicago 25, Ill.

Commercial Trades Institute
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Hollywood Radio & Television Institute
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Industrial Training Institute
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Chicago 25, Ill.

International Correspondence Schools
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Radio–Television Training School
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NOTE: This is merely a reference list of some of the many home study schools offering electronics courses. It does not constitute endorsement or recommendation in any way.

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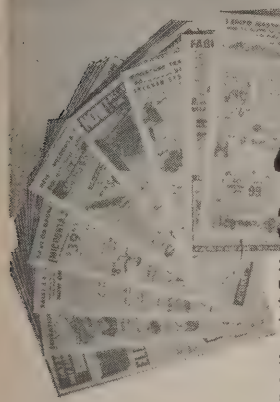

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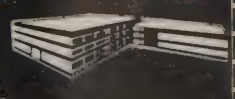


The DIODES CAN OSCILLATE

Nonamplifier oscillators use diode connected tubes or transistors, or crystal diodes

By I. QUEEN
EDITORIAL ASSOCIATE

MOST oscillators are the feedback type. Actually, these are amplifiers which feed back a portion of their output to reinforce their input (see Fig. 1). This lowers the effective resistance. When circuit resistance drops to less than zero, even the slightest voltage disturbance will build up. Eventually the circuit oscillates at full intensity. Since amplification is involved, we expect these circuits to include one or more triode or multi-element devices.

Certain nonamplifying devices—including diodes and thermistors—can also be adjusted for negative resistance. Therefore they can oscillate. One type of diode oscillator was described by Rufus P. Turner in RADIO-ELECTRONICS in October, 1949 (page 47). Fig. 2 shows his circuit. A 1N34 is reverse-biased (with between 50–175 volts) to its negative resistance region (Fig. 3). Here an *increase* in voltage causes a *decrease* in current. With the audio transformer shown in the diagram, the output is in the audio range. Up to 1 mc can be obtained with a suitable tank.

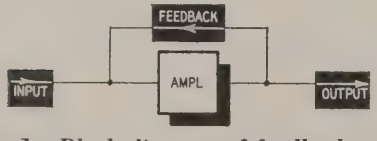


Fig. 1—Block diagram of feedback type oscillator.

Reverse-biased diode oscillators were known more than 30 years ago. Fig. 4 is a diagram from an article in THE EXPERIMENTER of March, 1925 (page 299), describing the experiments of the Russian scientist Lossev. The diode is a zincite crystal, and about 12 volts reverse bias is required. The oscillation frequency is determined by C1, L2. The other network (C2, L3) prevents rf from entering the battery.

A different kind of diode oscillator* is described by Thomas E. Fairbairn in RADIO-ELECTRONICS in December, 1953 (page 76). Known as the "ionic oscillator," it consists of a gas tube and voltage source. (See Fig. 5.) Electrons flowing through the tube ionize the molecules of gas and set them vibrating. The oscillating frequency depends only upon the tube type and not upon any external tank. If plate current is held to a minimum, the wave is a pure sinusoid and stable. Note that the tube is diode-connected. The grid may be used as modulate and control the oscillations, but is not needed to generate them.

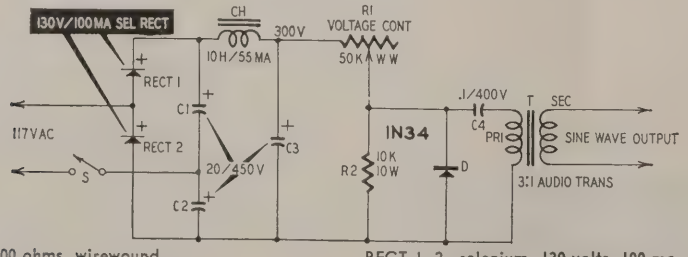
Use a transistor

From recent experiments I find that a *transistor* can also be connected as a diode oscillator. The circuit seems to combine certain features of the reverse-biased diode and of the ionic oscillator. It is shown in Fig. 6. The p-n-p transistor is diode-connected and the base is left free. R1 is a limiting resistor to protect the circuit and transistor. R2 controls the bias current. Both resistors are suitably bypassed. Sometimes, R3 (unbypassed) will also be needed for waveform control.

Transistor types 2N112, 2N112A and CK768 were found suitable as diode oscillators. No doubt others may also give satisfactory results. Low-frequency types such as the CK722 and 2N107 *did not work*, at least not at the low voltages I used. Optimum voltage seemed to be about 22.5 or slightly higher. Some transistors oscillate well with a 22.5-volt battery. For convenience I used a 45-volt battery for transistors which refused to oscillate with 22.5 volts. Of course, the higher voltage requires a high series resistance (R2).

Nearly every transistor tested (of the types mentioned previously) was found to oscillate. Optimum reverse current is approximately 0.4 to 0.5 ma in nearly every case, although one unit required as high as 0.8 ma. In general, the output waveform is sinusoidal when the current is kept low. The sine amplitude varies between 0.1 and 0.5 volt. The 2N112 generates a sine wave of about 8 or 9 kc. The CK768 frequency is approximately 3 times greater, near 24 kc.

*Patent No. 2,607,897



R1—pot, 50,000 ohms, wirewound
R2—10,000 ohms, 10 watts, wirewound
C1, 2, 3—20 μf, 450 volts, electrolytics
C4—0.1 μf, 400 volts
CH—ac–dc choke, 10 h, 55 ma
D—1N34
RECT 1, 2—selenium, 130 volts, 100 ma
S—spst toggle
T—audio transformer, 3:1 ratio
Chassis, to suit
Miscellaneous hardware

Fig. 2—Diode oscillator uses 1N34 crystal. Transformer secondary is higher-impedance winding.

Fig. 3—Crystal voltage-current curve shows negative-resistance point.

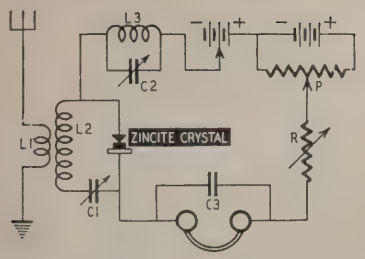


Fig. 4—This diode oscillator circuit appeared in 1925.

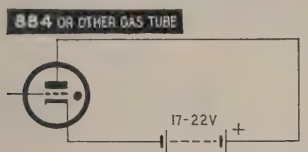


Fig. 5—Gas-diode oscillator. Grid can be used to modulate oscillations, but is not needed to generate them.

As bias current is increased, the waveform becomes distorted. Beyond a certain critical point the transistor breaks into sawtooth generation, with a large increase in amplitude. Unlike the "ionic" or sine condition, it is possible to vary the sawtooth frequency over a wide band. With one particular 2N112 unit, the sawtooth frequency was 12 kc with 1-ma bias current. At 0.5 ma, the frequency dropped to 6 kc. With a 0.5-μf capacitor shunted across the transistor, frequency was reduced to only 300 cycles. The sawtooth amplitude remained nearly constant throughout this wide band. Any intermediate frequency may be obtained by a suitable value of bias current or capacitor shunt.

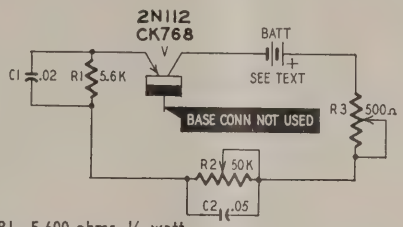
Of a very large number of transistors tested here, two gave an unusual result. As the bias was increased from some low value, a pure sine wave was observed but it quickly died down to zero. Another increase brought the wave back but again it died out. Each time, the control could be backed off and advanced with momentary appearance of the sine wave. With these two transistors, *reversing* the voltage permitted normal oscillation. In other words, the *positive* terminal was connected to the collector.

If your transistor shows a sawtooth or distorted output even with R2 set to maximum resistance, add R3, an unbypassed resistor. This has little effect on bias current so you retain sufficient input (and therefore output). However, even a small value for R3 eliminates distortion from the wave and leaves a pure sine wave. This is similar to the ionic oscillator, where for best waveform Fairbairn recommends a higher voltage and higher series resistance.

Tests with transistors

My tests show that only about one out of eight transistors refuse to oscillate in the Fig. 6 circuit. To test a transistor for suitability, connect it as shown in Fig. 7. Start with R2 set for maximum resistance. Now slowly reduce the resistance while observing the voltmeter. The voltage will rise, also, as the current grows and will reach a peak. After that, the voltage will begin to *drop* even though the current continues to rise. This indicates the negative resistance region. If the peak occurs below 19 or 20 volts, it indicates that the transistor will oscillate when used with a 22.5-volt battery. If the peak appears at a higher value, you can use a 45-volt battery with suitable series resistance (R2).

The reader may point out that the 2N112 and CK768 both specify 15 volts maximuum between emitter and collector. More than half of the transistors tested here reach their peak voltage at less than 17 volts so there is little if any overload when the transistor is used in the negative resistance region.



R1—5,600 ohms, ½ watt
R2—pot, 50,000 ohms
R3—pot, 500 ohms
BATT—see text
C1—.02 μf, 200 volts
C2—.05 μf, 200 volts
V—2N112, CK768
Chassis, to suit
Miscellaneous hardware

Fig. 6—The p-n-p transistor in a diode oscillator circuit.

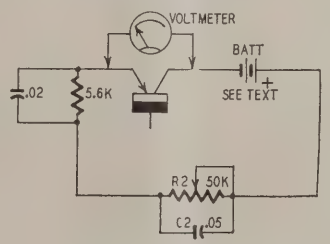


Fig. 7—Testing transistors for use as diode oscillators.

However, other transistors will require approximately 20 volts or more to reach negative resistance. While this appears to be rather high, it has been applied for many hours to several such transistors with no apparent damage to them.

When the circuit is adjusted for sine generation and low output, it is highly sensitive to temperature. To show this, set R2 so that sine output is 0.1 volt or less. Now if you touch the transistor for a second or two, the frequency will start to rise and the amplitude will fall. In most cases the sine wave will disappear within a few seconds. It will return when the transistor has cooled if you haven't changed R2's setting. By calibrating the control you will have some sort of temperature indicator. If the potentiometer is set high enough, so that the wave doesn't go to zero, you will note that the frequency rises considerably with temperature. Touching the transistor for about 2 seconds may cause its frequency to rise from 8 to 9 kc in a very short time.

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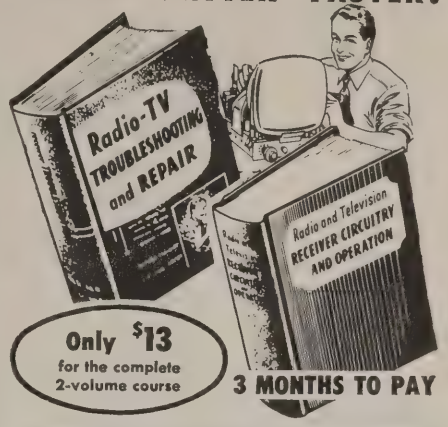
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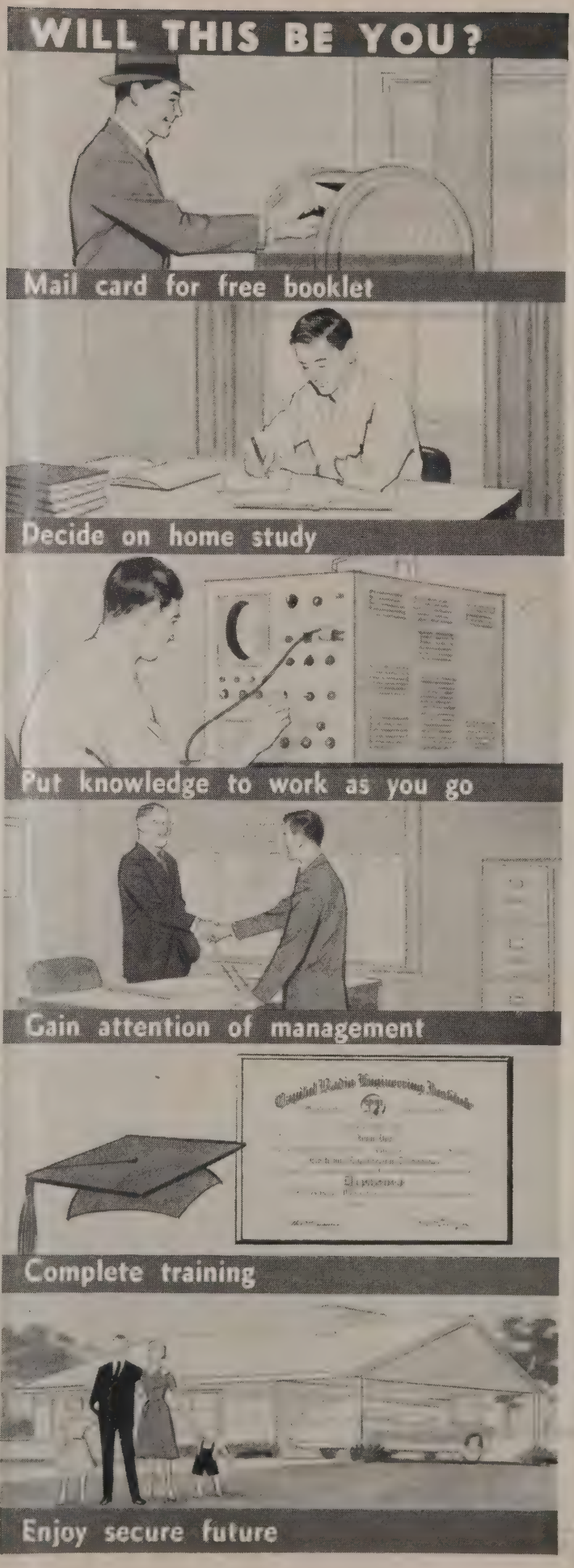
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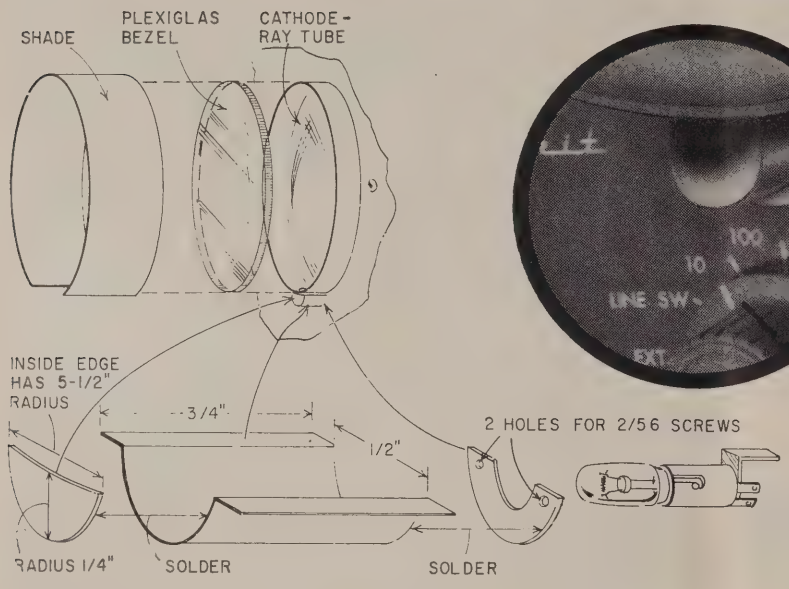
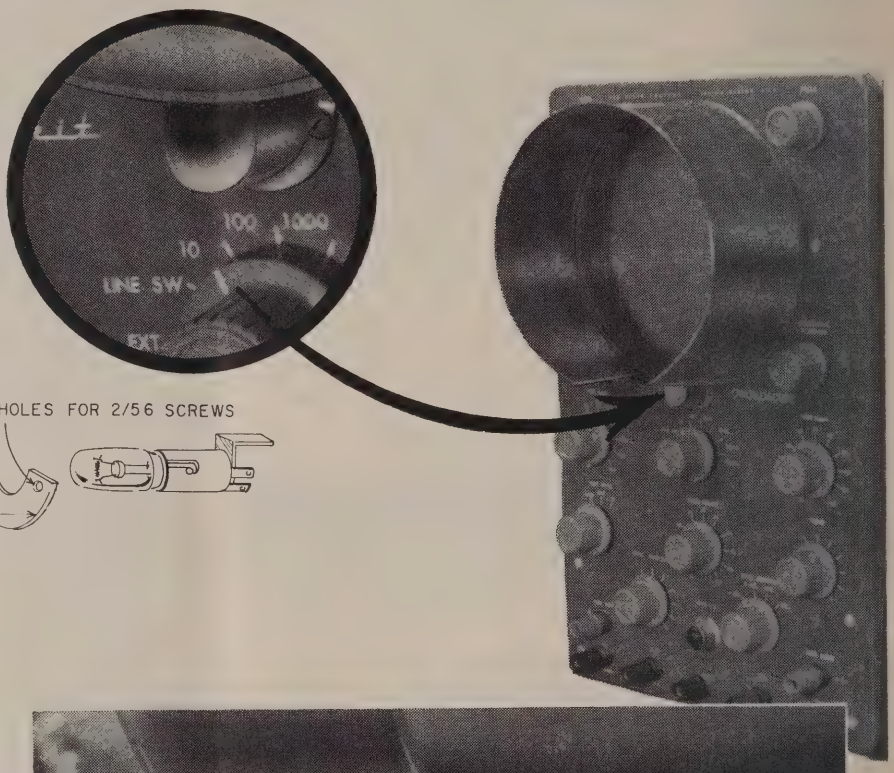
OSCILLOSCOPE COMFORTS

These few simple gadgets that you can easily put together will make life with your scope a lot easier, and perhaps help make your viewing more accurate

By T. J. BOPKINS



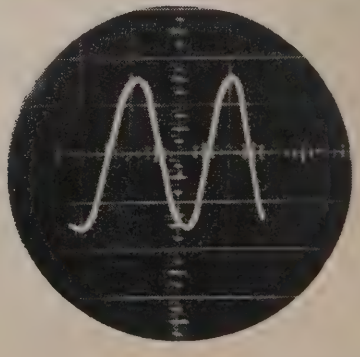


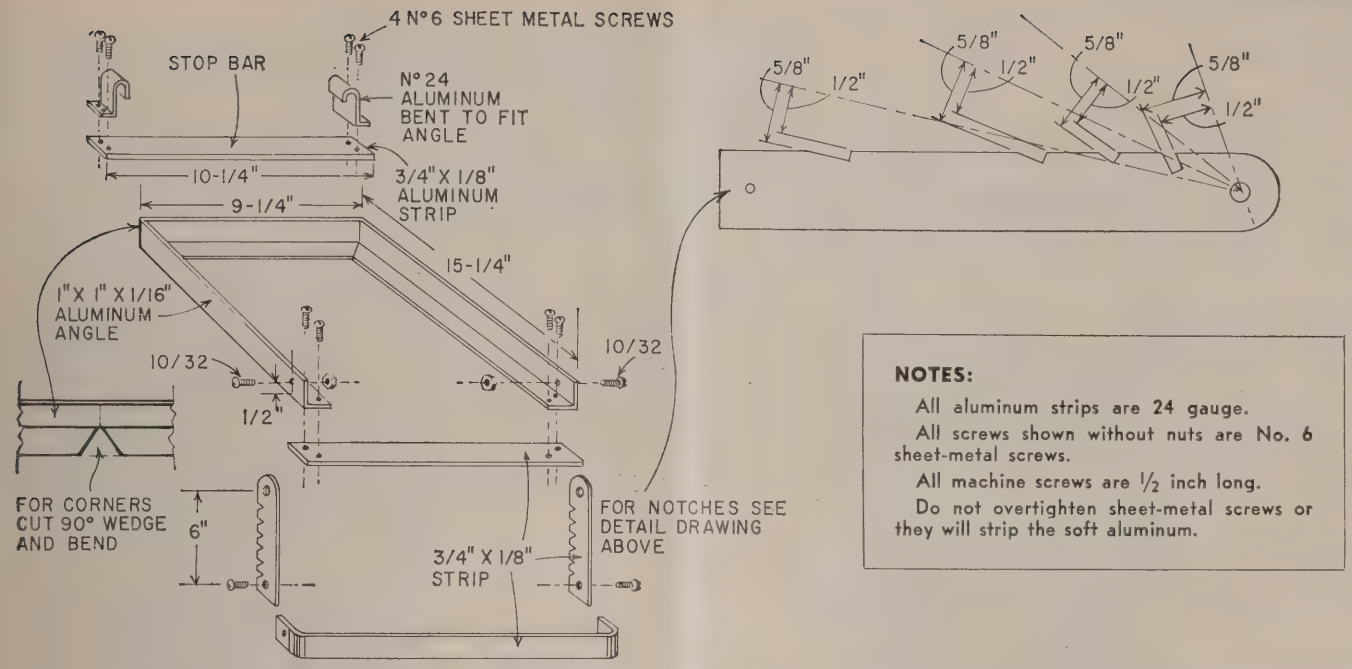
ENVIOUS of the man whose scope has a lighted graticule? You don't have to be. Here is a simple way of adding an illuminated graticule to your scope.

Cut a disc of clear Plexiglas to fit your scope's bezel ring (use ¼- or ⅜-inch clear Plexiglas). Then flame-polish the edge and paint it black, except for a ½-inch section at what will be the bottom. On this disc you can scribe any desired scales or pattern with a sharp pointed tool. Be careful; once you scratch the surface, it is very difficult to remove the mark. At the bottom of the metal bezel ring, drill a ¼-inch hole. Just below this on the panel, drill a ½-inch hole as close to the bezel ring as possible.

Next, make the tin housing. The top can be trimmed after the end is attached, but the bottom flange must be shaped beforehand. Flow solder thickly around the edges and, when cool, trim with a small file and paint the outside the same as the scope case.

The housing is installed with two 2/56 screws and nuts. The pilot lamp fits through the hole and into the housing. To show the graticule lines in color, insert a sheet of colored cellophane (preferably blue or green) between the CRT face and the Plexiglas disc.





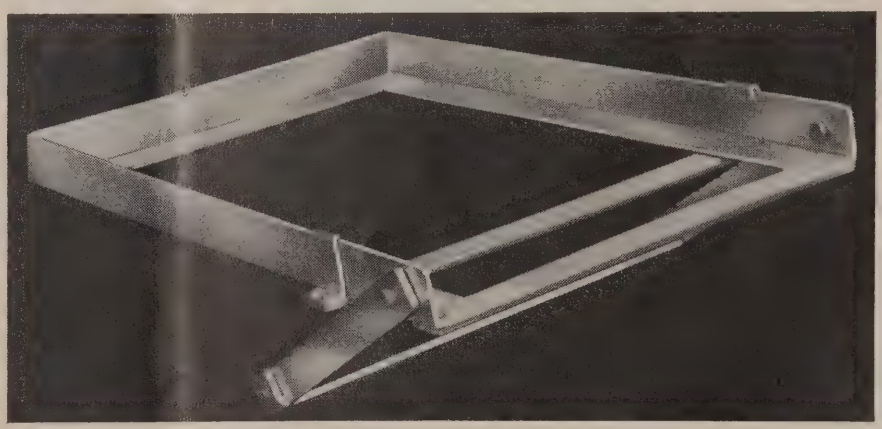
NOTES:

All aluminum strips are 24 gauge.

All screws shown without nuts are No. 6 sheet-metal screws.

All machine screws are ½ inch long.

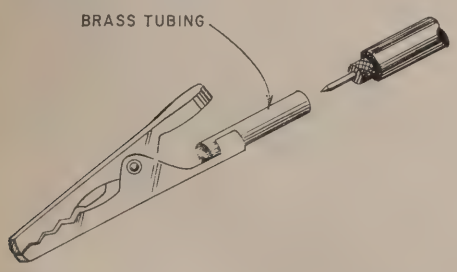
Do not overtighten sheet-metal screws or they will strip the soft aluminum.



TIRED of craning your neck to see the scope face when the scope is on the bench? Try this adjustable rack. It is made from strips of 1-inch aluminum angle and ¾ x ⅛-inch aluminum strip. You can use sheet-metal screws or flush rivets to hold the works together.

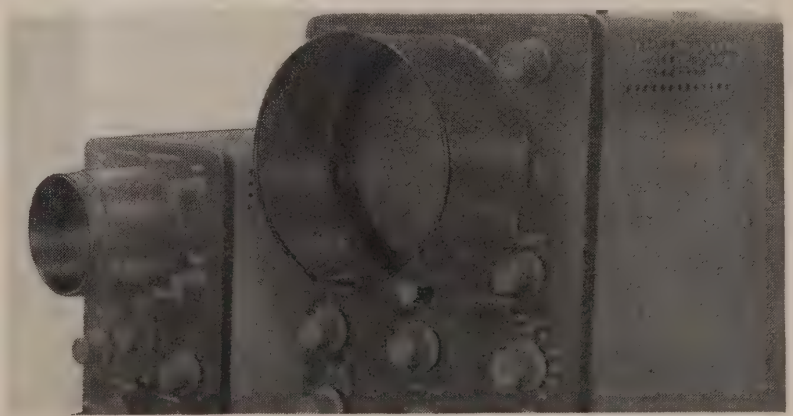
To adjust the rack, set it up on the highest position with the legs straight down, and slide the stop bar to the desired position. Then lower the whole thing until the stop bar slips into a notch. Of course, you can cut as many notches as necessary.

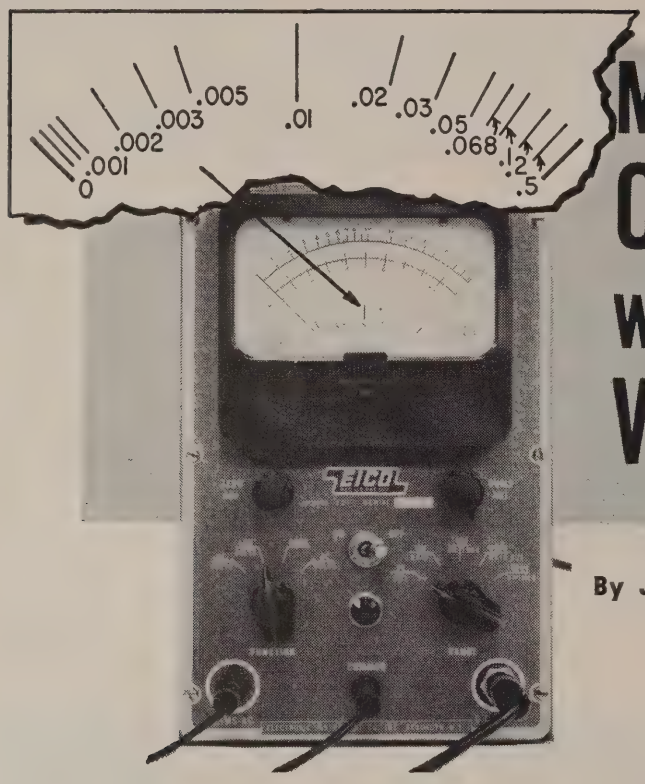
ANOTHER handy little gizmo is a miniature alligator clip that has



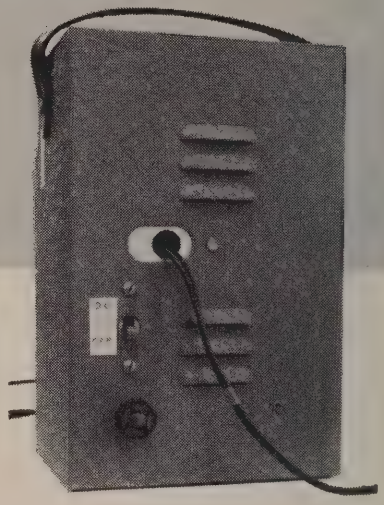
been soldered to a short length of 5/64-inch inside-diameter brass tubing. Pinch the tubing a little, and a test-prod tip will fit tightly. Then you can clip it to any part of a circuit you want and have both hands free for any work or scope adjustments that may be necessary.

REFLECTIONS on the screen are a nuisance and, unless you like to work in the dark, a shade over the scope face is a must. Here are two shades which you can make in minutes. For a 5-inch scope take an empty coffee can, remove its bottom with a can opener (the kind that leaves a smooth edge) and slit the can body with a pair of tin snips. Paint the outside to match the scope and the inside a flat black. Presto! You have a scope shade that snaps on. For a 3-inch scope I used a peanut can. It very nearly fitted the bezel, so I squeezed it slightly out of shape and it stays on beautifully. END





MEASURE CAPACITANCE with a VTVM



By JOHN L. JANNING, W8QCN

TECHNICIANS and experimenters can make good use of a capacitance meter. The technician looks at such a unit as an appealing investment while to the experimenter it is a valuable luxury. But by making a simple inexpensive accessory for your vtvm, you can add a capacitance scale that will measure from 250 $\mu\mu$f to 0.5 μf.

Fig. 1 is the basic circuit. A filament transformer delivers 6.3 volts, which is then rectified. This gives us pulsating dc which cannot be measured on the dc volts range of a vtvm. (This is not true of a vom.) If a capacitor is placed across the vtvm's input (shown in dashed lines), only the filtered portion is read. The larger the capacitor, the higher the dc reading. If a large capacitor—0.2 or 0.5 μf—were placed across the vtvm, the reading would be off scale.

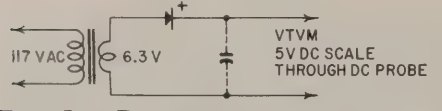
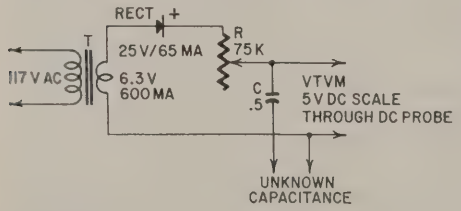


Fig. 1 — Basic capacitance-measuring circuit.



R—pot, 75,000 ohms
C—0.5 μf
RECT—selenium, 25 volts, 65 ma (International Rectifier Q1H or equivalent)
T—Filament transformer: primary 117 volts; secondary 6.3 volts, 600 ma (Triad F-13X or equivalent)
Chassis box to suit
Miscellaneous hardware

Fig. 2—Simple circuit for an accessory type capacitance meter.

To handle this problem, resistor R1 is inserted as in Fig. 2. Now it is possible to adjust the reading to bring high-value capacitors within the vtvm's 5-volt range. Next, we add capacitor C so the capacitance scale can be zeroed easily.

To use this circuit, set the vtvm to its 5-volt dc range and connect the capacitance meter to the vtvm's dc input *through the dc probe*. Then, zero the left side of the scale with the vtvm's zero-adjust control. The right side of the scale is zeroed by shorting the unknown-capacitor probes and adjusting R1 for full-scale deflection.

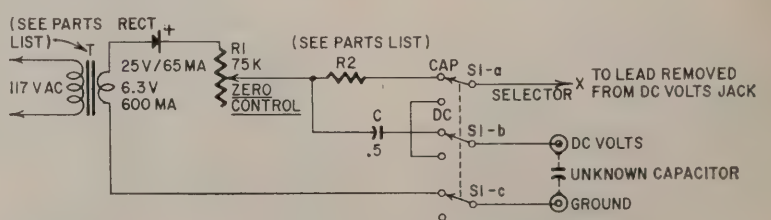
When calibrating the capacitance scale for the vtvm, make sure that the vtvm has been turned on for at least 15 minutes. Check the scale zeros next. Then connect good-tolerance known-value capacitors to the unit and mark the meter reading with the value of the capacitor. The front-panel photo shows how this may be done. The unit will be only as accurate as the capacitors used to calibrate it. So if close-tolerance capacitors are not available, use the average reading of several capacitors of the same value.

When using the instrument, readings that show lower capacitance than marked on the capacitor indicate changed value or a slightly leaky condition. A high reading usually indicates a very leaky capacitor. Use the ohms scale to make certain.

If you don't want a separate accessory cluttering up the bench, build the unit right into your vtvm. If you do so, you can use the filament winding of the vtvm's power transformer to supply the necessary 6.3 volts. The circuit is shown in Fig. 3. In this circuit, a high-value resistor equal to the one in the meter's dc probe is used as R2. The switch and the high-end zero control can be mounted on the back of the vtvm.

The lead connected to the vtvm's dc volts jack is removed and connected to point X in Fig. 3 and the arm of S1-b is connected to the jack in its place.

When capacitance is read with this unit built-in, a straight probe is used. The vtvm's dc probe will give a false or no reading. If the Fig. 2 circuit is used (external accessory), the standard dc probe is used. END



R1—pot, 75,000 ohms
R2—resistance equal to resistor in vtvm's dc probe
C—0.5 μf
RECT—selenium, 25 volts, 65 ma (International Rectifier Q1H or equivalent)
S1—3-pole 2-position slide
T—use filament winding of transformer in vtvm
Miscellaneous hardware

Fig. 3—When the unit is built into the vtvm, use the existing transformer for the capacitance meter's 6.3-volt ac supply.

MANY SOCKETS SPEED TUBE CHECKING

More sockets and fewer controls on the face of your tube tester can convert lost time into found money

By WILLIAM KELVIN*

Mini-Check MC-1 tube tester has selector, load and function controls.

Fast Check FC-2 tube tester has only two controls—selector and load.

TUBE testing should be a fast, simple process. The multiple-socket (or prewired-socket) tube tester is a big help in making it such. This instrument lets the service technician give good service without losing money, as he would if he spent a half-hour on each service call just testing tubes. The easy way out of this spot is to dispense with the tube tester and rely on tube substitution. But such a method passes up many legitimate tube sales.

This article describes two types of circuitry used by Century Electronics in multiple-socket tube testers. Before we go into these circuits, let's review basic tube-testing principles.

All emission testers, whether dynamic (ac test signal) or static (dc test signal), use a circuit similar to the one in Fig. 1. An ac signal is applied between grid and cathode of a diode-connected tube, while the heater is powered by a separate ac source. The tube, acting as a rectifier, conducts on positive half-cycles. Pulsating dc flows through the external circuit and gives a meter indication. Resistor R limits maximum current to a safe value.

If cathode emission is substandard, the meter reads lower than for a normal tube. Thus, the lower part of the meter scale can be a red area labeled BAD, the upper part can be a green area labeled GOOD, and our basic tube tester is born. This article is limited to this type of emission tester, since it is in the overwhelming majority.

All tube testers must check for inter-element shorts as well as quality. In Fig. 2 the cathode of a tube is connected to one side of the transformer's secondary, and all other elements, including the heater, are connected to the other side of the same winding. If there is a short between the cathode and any other element, current flows, a voltage drop appears across the neon bulb, and the short indicator lights. The capacitor and resistor control the sensitivity of the leakage indicator, and keep normal tube emission from appearing as a short.

As an introduction to multiple-socket instruments, let's first take a look at the *Freepoint-Lever* tube tester.

In Fig. 3, a multi-element tube is connected to measure cathode emission through its pentode section. The switches may be lever-action or, in lower-priced instruments, slide switches. Note that each switch lever connects to an element of the tube. When the lever is thrown to the left, it connects its respective tube element to one side of

(*Continued on page* 92)

*Chief engineer, Century Electronics Co. Inc., Mineola, N. Y.

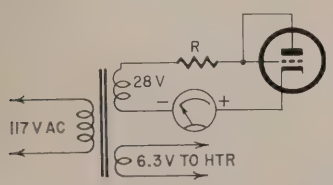


Fig. 1—Basic tube testing circuit shows cathode emission check.

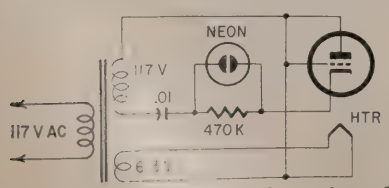


Fig. 2—Basic method of testing for shorts.

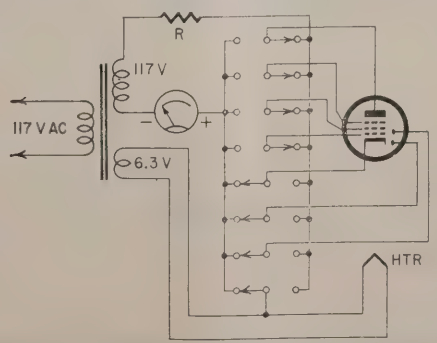


Fig. 3—Simplified emission-test circuit using Freepoint-Lever switches.

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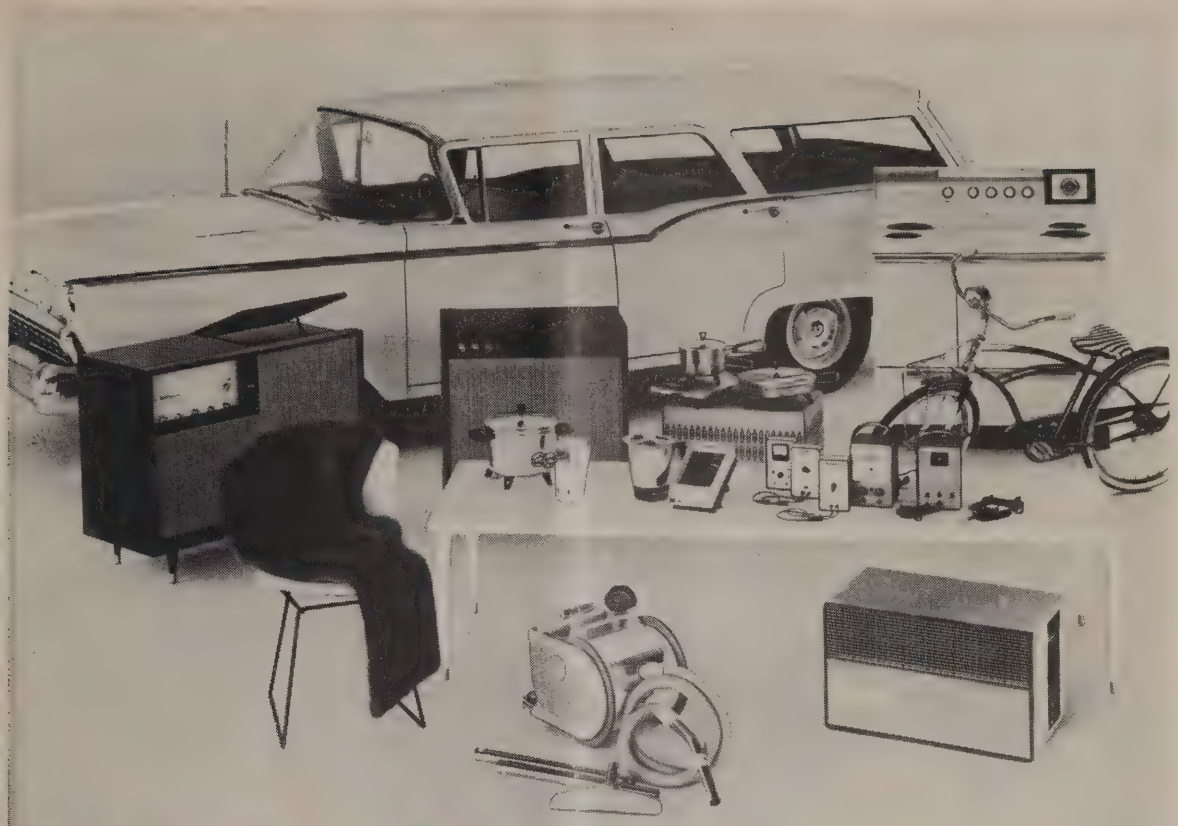

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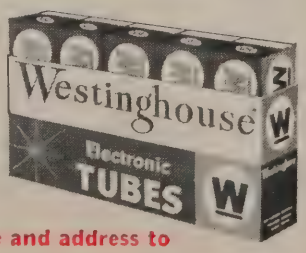

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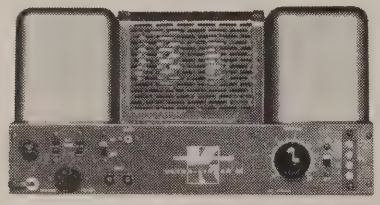

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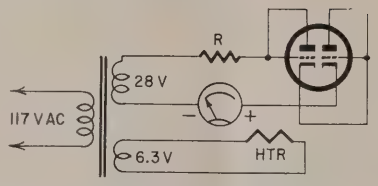


Fig. 4—Simplified quality test of a dual triode with both triode sections connected in series.

(*Continued from page* 89)

the transformer secondary. When the switch lever is thrown to the right, it connects its element of the tube to the other side of the transformer secondary.

Most lever-action tube testers have 10 levers, one for each base pin. There are a maximum of 9 base pins on any one tube, plus a top cap. By manipulating the levers, any tube element can be connected into either the plate or cathode circuit. Most tube testers of this type have two more positions which are not shown in Fig. 3. These are for applying heater voltage to the proper pins, and for open-circuiting any desired base pin.

In addition to 10 lever switches, these testers have a filament voltage switch, a plate voltage control and a load control. The more expensive testers have still more controls such as bias, etc. The additional controls make the instrument more versatile, but they also slow down testing.

Multiple-socket tube testers

These units can have a lot of sockets and a minimum of controls or fewer sockets and more controls. Two units which show this rather clearly are the *Fast Check* and *Mini-Check* tube testers. The Fast Check has 41 sockets and 2 controls. By adding a cathode switching circuit, you get the Mini-Check which has 3 controls (the 2 on the Fast Check and an added cathode switch) and only 17 sockets.

There are two keys to the success of multiple-socket testers:

• **Many tubes use the same switch settings.** This is easily checked by examining a common tube like the 6K6 and noting that its base-pin arrangement is one that is used by a large number of other tubes. This is true of many base-pin arrangements, and means that the service technician repeatedly sets up the same switch positions in the course of his tube testing. So, why not employ some sort of fixed setup? Since these lever switches do nothing but "wire up" a socket in a particular manner, the answer is to use a prewired socket for this tube. It will serve, not only for the list of tubes that have the same base-pin arrangement, but also for other tubes with slightly different ones.

If you classify tubes into groups with the same pin arrangement, you wind up with a panel of prewired sockets, and *no lever switches!* Obviously, if *every* base-pin arrangement were used, too many sockets would be needed. The number can be reduced by careful combination of groups of tubes with similar base diagrams.

Now what about the other switches? Every time you eliminate a switch you must either increase the number of sockets or sacrifice some accuracy of the test. If the filament-voltage selector switch is eliminated, there must be a complete set of sockets for each popular filament voltage. For example, the 6L6, 12L6, 25L6, 35L6 and 50L6 are all of the same type, but each needs a different heater voltage. On a panel with no filament switch, there would have to be five sockets just for this group. One manufacturer of a tube tester with no filament selector switch has 123 sockets on the instrument panel.

The objection to limitless numbers of sockets is that size and cost become too large.

You will note that for many tubes the load control setting (it varies the series resistance, R, of Fig. 1a) is the same, and this grouping is enlarged if you include tubes which have *almost* the same load setting. This suggests replacing the load control with a fixed resistor equal to the most commonly

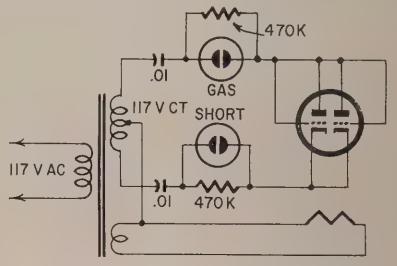


Fig. 5—Basic short and gas tests in a dual-triode tube.

used load value. Although this has been done in some instruments, it reduces the tester's accuracy. Such a drawback can be partly overcome by using two or more values of fixed load resistance, but again this entails increasing the number of sockets to accommodate tube groups with the same base-pin arrangement but which take different load-control settings. In general, the load control should be retained in multiple-socket testers.

The plate switch, however, is one that is readily eliminated since the majority of tubes are checked at the same plate voltage. Only a few extra sockets are needed to overcome the inflexibility caused by this step, and most multiple-socket tube testers have no plate switch.

• **More than 95% of interelement shorts involve the cathode.** This permits a great reduction in the required number of sockets since the very rare types of interelement shorts introduce only a small chance for error in tube testing if they are omitted. These rare shorts include screen-to-suppressor, plate-to-plate (in dual-section tubes), etc.

With the various switching economies described, major manufacturers of multiple-socket tube testers have produced instruments whose panels have from 12 to 123 sockets, and with between 1 and 5 control knobs.

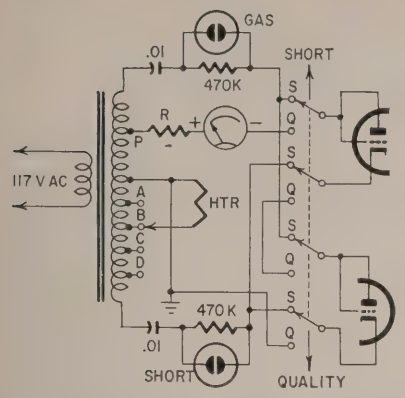


Fig. 6—How a dual triode is switched from a parallel to a series connection.

Here is a challenge to the service industry—an economy in time at a slight cost in accuracy! Is it acceptable? Service technicians have replied with a powerful affirmative which has been proved by the thousands of instruments sold.

2 controls and 41 sockets

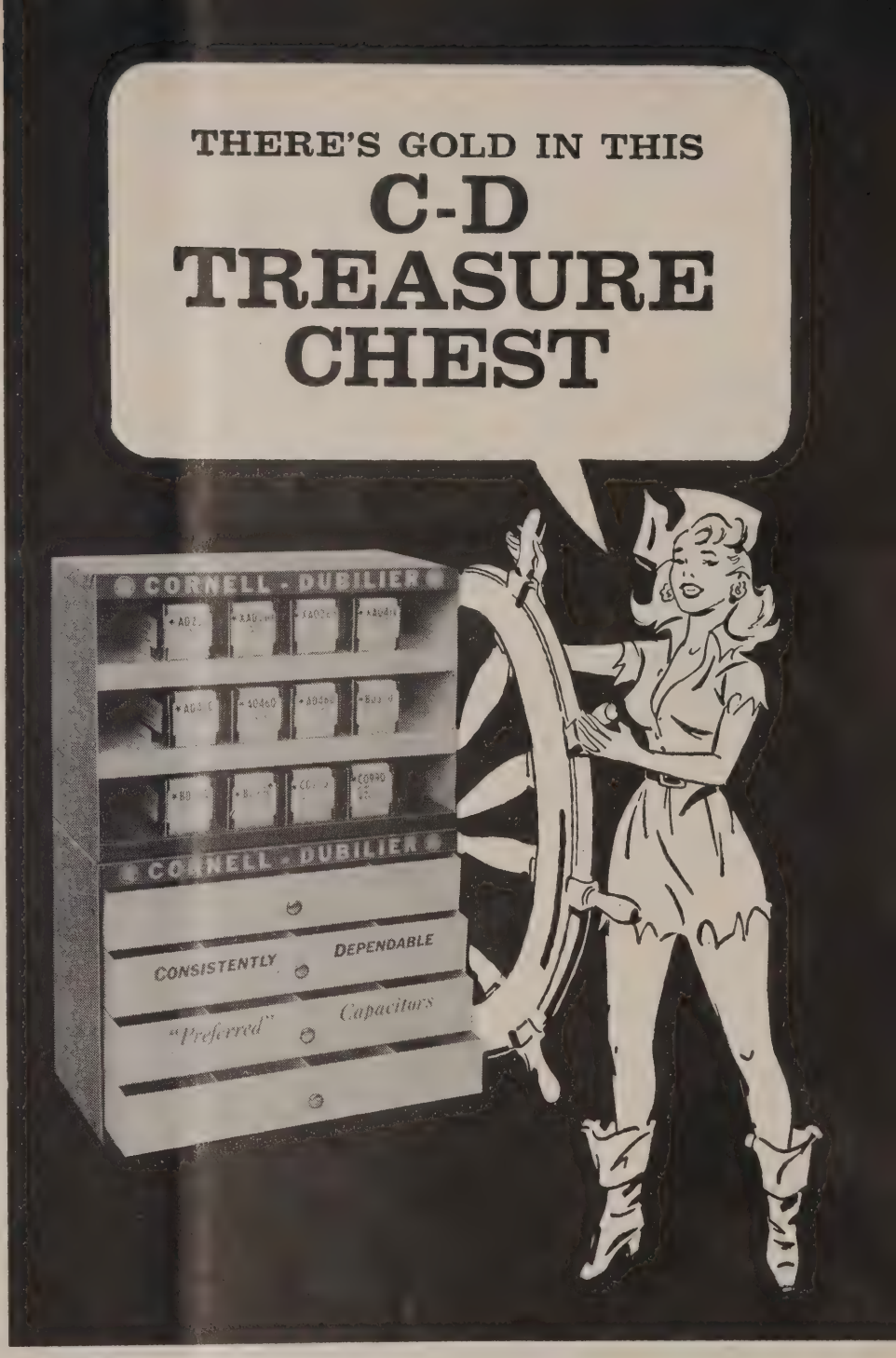
The Fast-Check circuit uses a filament-voltage selector and a load control. It has 41 sockets and tests over 700 tube types. It features a special manner of testing dual-purpose tubes so that tube sections are in parallel for the short test, and in series for the quality test.

Fig. 4 shows how dual-purpose tubes are checked in a single step. If both triode sections have normal emission, the meter will indicate a GOOD tube. But if one section has low emission, the meter will indicate a BAD tube, even though the first section is good. Thus, the meter reading is governed by the condition of the poorest section. This method applies whether the two sections are alike or not. The only requirement is a separate cathode for each section.

For dual-section tubes that have only one cathode, such as a 5U4, two separate tests can be made, or the two sections can be tested in parallel.

Fig. 5 shows the same tube shown in Fig. 4, but now it is connected with the two sections in parallel. Notice that the neon lamp labeled SHORT will light if the tube has a cathode-to-heater short. This is the most common type of short found in tubes. This circuit follows the EIA standard of ½ megohm as the maximum tolerable leakage resistance between heater and cathode. The sensitivity of the SHORT indicator in this circuit is made a bit higher than ½ megohm so that it starts to show a faint flicker when cathode-to-heater leakage resistance gets down around 750,000 ohms. Still lower values of leakage resistance cause a brighter glow.

The GAS indicator responds to high gas content in a tube as well as to grid-to-cathode leakage. The sensitivity of this circuit is set between 3 and 5 megohms. Looking again at Fig. 5, notice that a grid-to-cathode short will light both neon lamps if the resistance



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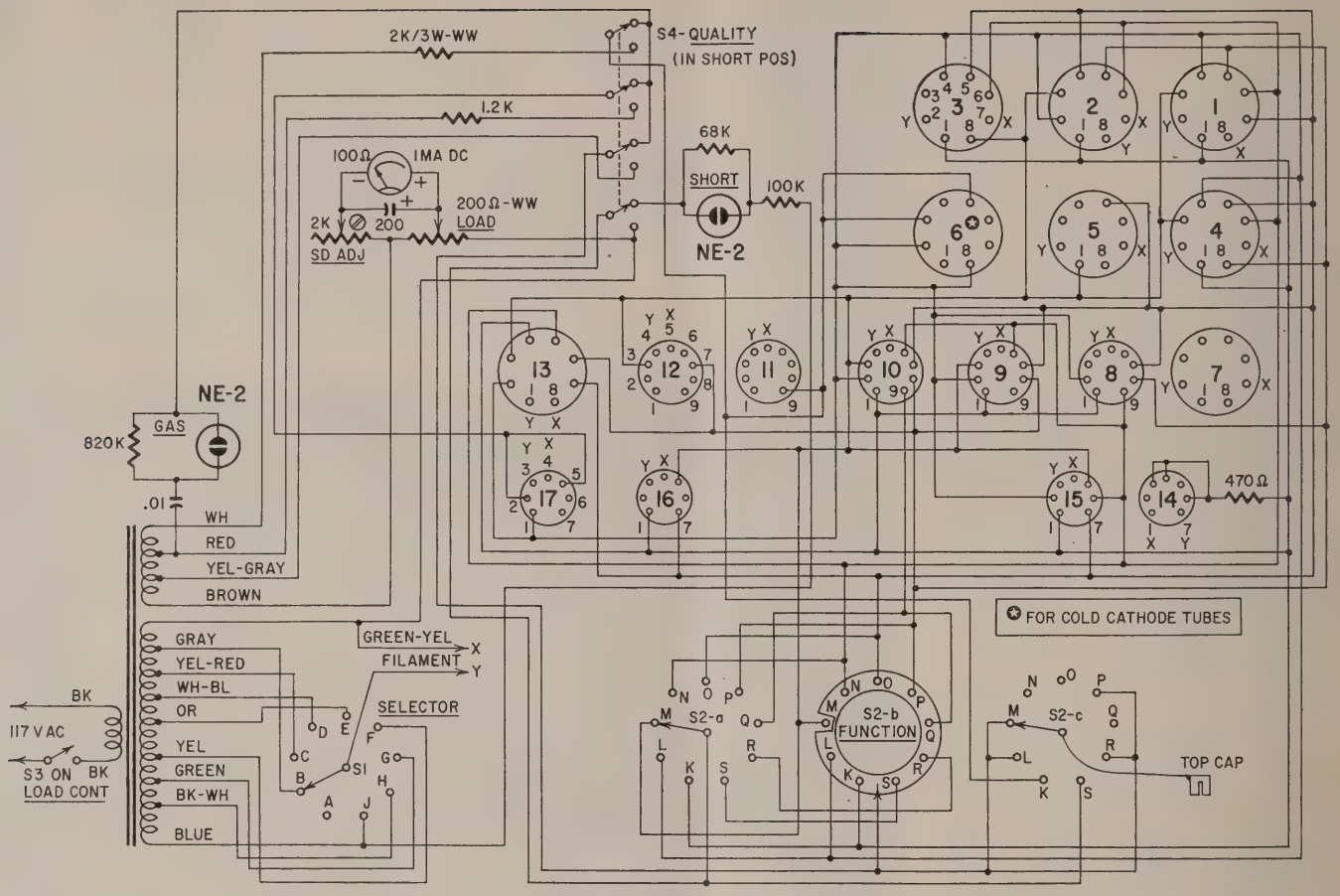

Fig. 7—Circuit of the Mini-Check, a 3-control 17-socket tube tester.

of the short is less than ½ megohm. If it is more than ½ megohm, only the GAS indicator will light. In tubes which have no indirectly heated cathode, such as 1U5, 5Y3, 1B3, etc., the filament serves as the cathode, and a short to the filament will cause the GAS indicator to glow.

The SHORT – QUALITY pushbutton switch on the Fast Check is an exclusive Century design. It switches dual-purpose tubes from the parallel hookup of Fig. 5 to the series hookup of Fig. 4. When the pushbutton is in its normal position, the tube sections are in parallel and the tube is tested for shorts. As soon as the button is pushed, the sections are in series and the tube is tested for quality.

The switch circuit in Fig. 6 is shown in the SHORT position. The circuit also shows various heater-voltage taps, labeled A, B, C and D. In addition, the plate-voltage tap, labeled P, is shown. This tap is usually about 25 volts above ground. The meter and load resistance are shown at the input or grid portion of the path which current takes during the quality test, but the meter and load could also be placed in the return or cathode path without affecting the test.

3 controls and 17 sockets

Another solution to the same problem is seen in the Mini-Check (see Fig. 7). By adding a cathode-selecting control (labeled FUNCTION on the panel), the number of sockets is reduced from 41 to 17, without affecting accuracy.

The key to the reduced number of sockets is in being able to connect the cathode return circuit to any tube base pin. In this way, the group of tubes with base-pin connections like the 6K6 can be expanded so tubes with their cathodes on some other pin besides pin 8 can be tested in the same socket. For example, in the 41-socket instrument the 6K6 and 6BG6 use different sockets because 6K6 has pin 8 as its cathode and 6BG6 has pin 3 as its cathode. In the Mini-Check, these tubes can be tested in the same socket.

In Fig. 8, we have a two-section wafer switch. Section A is a conventional one-pole eight-position wafer, while section B is a shorting ring *which shorts all contacts except one*. The arm of section A is returned to the cathode portion of the circuit, while the arm of section B is returned to the grid portion of the circuit. Tracing the circuit, you will see that the cathode of the pentode is isolated from the other elements and returned to the lower end of the transformer winding. The rest of the tube elements are tied together and returned to the grid end of the transformer winding, and the tube is set up properly for an emission quality test.

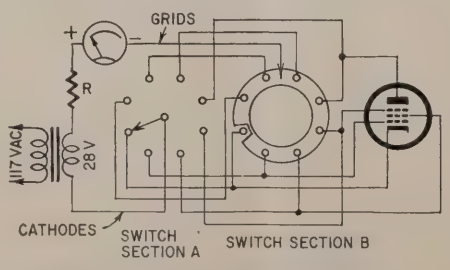

Fig. 8—Cathode-selecting switch action.

In the full circuit of the Mini-Check, shown in Fig. 7, you can see the third section of the cathode-selecting switch. This adds to the instrument's versatility. The other two controls on this instrument are the same as the two found on the 41-socket version, namely the LOAD and the filament SELECTOR. The 17-socket Mini-Check does not require switching dual-purpose tube sections from parallel to series, so the short–quality switch is less complicated.

This article shows that there are many ways to get an accurate tube test with a limited number of controls. It is even possible to have an instrument with no controls at all, which would have as many sockets as there are types of tubes. Conversely, as greater degrees of accuracy are required, more switches and controls must be added until all the time-saving advantages are lost.

The two-control Fast Check and the three-control Mini-Check tube testers represent the most popular circuits used today in multiple-socket testers.

This relatively new way of testing tubes has earned a definite place in the test equipment picture because it is a proven time saver. And more than ever, these days, time is money! END

TECHNICIANS' NEWS

PHILCO SHOWS TECHNICIANS

Philco invited by first class mail during June and July 150,000 independent service technicians to attend distributor showings of 1960 home electronics products. TV sets were seen in operation with the back panels removed, and engineers in attendance to discuss technical and service features of the new receivers. In addition to electronics, Philco's home appliances were also demonstrated and examined. Over 100 such showings were scheduled over the country. First affair was in Shreveport, La., on June 12.

TEAM ELECTS

The annual election of officers for the Electronic Association of Missouri (TEAM) in St. Louis put these men to work for the next year: W. C. Pecht, president; Stanley Siegel, vice president; Arthur Mayer, secretary-treasurer.

CCTV LECTURE

More than 300 technicians listened to a talk on closed-circuit television by Joseph Kerner of Blonder-Tongue Labs. Inc., at a meeting of CETA (Certified Electronic Technicians Association) at the New York Trade School. CETA had invited other technicians associations in the area to attend, and many did so.

After the meeting, lecture and question-and-answer period, Blonder-Tongue presented some CCTV equipment to the school. CETA's president Bob Cornell also presented CETA's "plaque of devoted and distinguished service" to Paul Zbar of the school.

PHILCO FIGHTS LOW RATES

The Massachusetts Joint Standing Committee on Mercantile Affairs held a public hearing on a bill proposed to set a *maximum* fee of $3 for any service work performed on household appliances, including TV sets and radios. Philco's service district representative for New England, Edward P. Burke, appeared to speak against the bill. He said that Philco felt the proposed law was impractical and unrealistic.

"Limiting payment for service work performed on household appliances to $3 would seriously threaten the business in which Philco is engaged. It would jeopardize the convenience, safety and welfare of hundreds of thousands of users of appliances in this Commonwealth, and would work an extreme hardship on those citizens employed in servicing these products...

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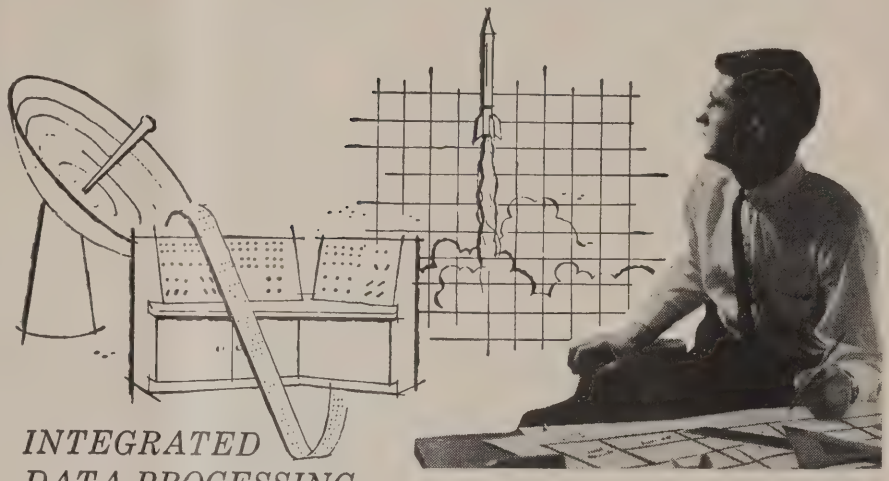

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PHILLY TECHNICAL MEET

Electronic servicing was the keynote of the Electronic Technicians Forum held in Philadelphia June 12, 13 and 14. The forum, held under the auspices of the Television Service Association of Delaware Valley, was attended by a number of industry representatives other than service technicians, and several demonstrations and displays were staged in the meeting hall in addition to those given in connection with the talks.

The discussions and demonstrations included electronic cooking and electronic refrigeration, ultrasonic washers, closed-circuit TV, transistor circuits and servicing, and no less than three discussions of printed circuitry, including recent developments and methods of servicing printed boards. Of the 14 talks, only 3 were specifically confined to entertainment electronics, one a discussion and demonstration of an electronic organ, one on record changers and one on color TV installation and servicing. Business methods that pay off were also covered, and the technicians were even given a preview of TV as it may be 20 years in the future.

The Pennsylvania State Federation of radio and television service associations met during the forum. The delegates explored plans for further extending and improving cooperation with the state broadcasters' association in selling the radio receiver owner on the idea of keeping his radio in trim. Objective was an intensified campaign next May, the broadcasters' Radio Month.

Attendance at the Friday and Saturday sessions of the forum was light, but more than a hundred turned out to view the Radarange cooking, the closed-circuit TV and other demonstrations and talks Sunday. The banquet Saturday night was extremely well attended, not only by technicians and their wives but by representatives of the manufacturing and distribution fields. Donald H. Stover of the Industrial Relations

(*Continued on page* 100)

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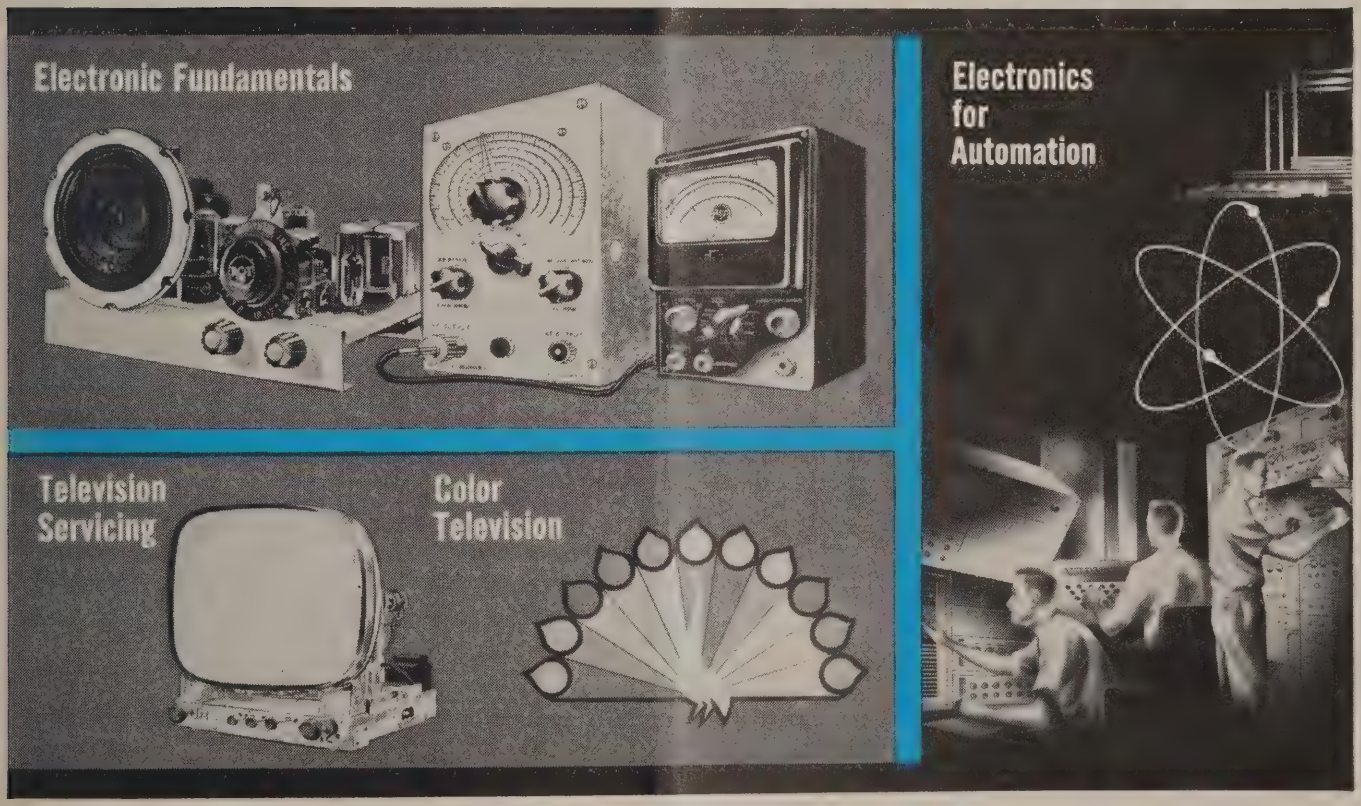

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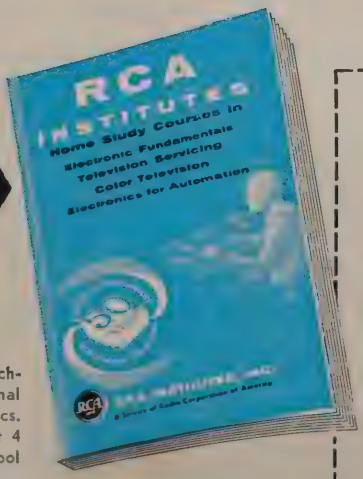

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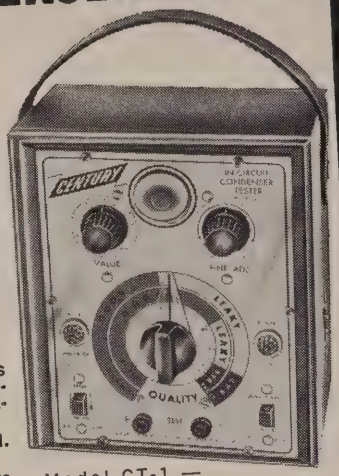

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SIZE: W–9" H–8½" D–2¾"

SPECIFICATIONS

• Checks emission, inter-element shorts and leakage of over 600 tube types. This covers OZ4s, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes • 3 settings enable a test of any tube in less than 10 seconds • Employs dynamic cathode emission test principles • 3½" D'Arsonval type meter — most accurate type available . . . its greater sensitivity means more accuracy . . . its jewel bearing means longer life • 17 long lasting phosphor bronze tube sockets • Combination gas and short jewel indicator • 9 filament positions • Handy tube chart contained in special back compartment • New tube listings furnished periodically at no cost • Detachable line cord

plus these BONUS FEATURES . . . found in no other low price tube tester

✓ Checks for cathode to heater shorts ✓ Checks for gas content ✓ Checks all sections of multiple purpose tubes . . . will pickup tubes with one "Bad" section ✓ Line isolated — no shock hazard ✓ Variable load control enables you to get accurate results on all tubes ✓ Positively cannot become obsolete as new tubes are introduced.

IN-CIRCUIT RECTIFIER TESTER

Model SRT-1

Checks all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc.

With the growing trend towards compactness, portability and low price, TV manufacturers are resorting more and more to producing series-string TV sets employing selenium, germanium or silicon power rectifiers. Now the need for an in-circuit rectifier tester is greater than ever.

THE SRT-1 CHECKS ALL POWER RECTIFIERS IN-CIRCUIT AND OUT-OF CIRCUIT WITH 100% EFFECTIVENESS FOR:

✓ Quality ✓ Fading ✓ Shorts ✓ Opens ✓ Arcing ✓ Life Expectancy

Model SRT-1—housed in sturdy hammertone finish steel case complete with test leads **$29.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
- Will not blow fuses even when connected to a dead short.
- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
- Cannot damage or over heat rectifier being tested.

SIMPLE TO OPERATE Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales. . . .

TRANSISTOR TESTER

Model TT-2

AN INEXPENSIVE QUALITY INSTRUMENT DESIGNED FOR ACCURATE AND DEPENDABLE TESTS OF ALL TRANSISTORS AND DIODES QUICKLY AND ACCURATELY

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors can develop excessive leakage, poor gain, shorts or opens, the need for TRANSISTOR TESTER is great.

Model TT-2 — housed in sturdy hammertone finish steel case complete with test leads **$24.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

• Checks all transistors, including car radio, power output, triode, tetrode and unijunction types for current gain, leakage, opens, shorts, cut-off current • Checks all diodes for forward to reverse current gain • All tests can be made even if manufacturers' rated gain is not available • Less than half a minute required for tests of either transistors or diodes • Large 3" meter is extremely sensitive yet rugged . . . with multi-color scales designed for quick easy readings • Power is supplied by an easy to replace 6-volt battery — current drain so small, service life almost equal to shelf life. Battery cannot be drained due to accidental shorting of test leads • Cannot burn-out its own meter or damage transistor or diode under test • Long test leads and insulated test clips enable tests without entirely removing transistor from circuit • Test leads are identified by E.I.A. color code so that connection to the correct terminal is assured • Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to check all new type transistors as they are introduced. New listings will be furnished periodically at no cost.

EASY TO BUY IF SATISFIED

see order form on facing page

FOR 10 DAY *FREE* TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NEW Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE * Patent Pending

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC–Ohms Probe ❸ Lo-Cap Probe ❹ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maize of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

SIZE:
W–7⅜"
H–9"
D–4¼"

FUNCTIONS

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

OUTSTANDING FEATURES

● Completely portable — self powered with long life batteries — permits use everywhere ● New advanced pentode amplifier circuit assures amazingly low battery drain ● Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s ● Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC ● Simplified multi-color easy-to-read 4-scale meter ● No heat operation assures rigid stability and accuracy ● Immune to power line fluctuations ● Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments ● Meter completely isolated — practically burn-out proof ● Hand-crafted circuitry eliminates the service headaches of printed circuitry ● 1% resistors used for permanent accuracy ● Separate RF ground return for low-loss RF measurement ● Micro-phone type co-axial connector ● Matching cover protects instrument face — snaps on and off instantly.

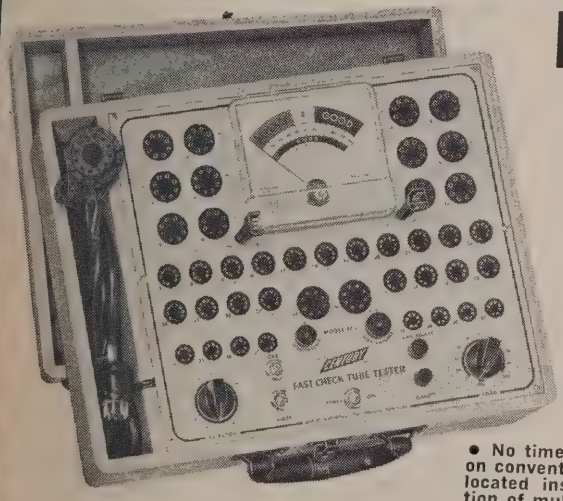
SPECIFICATIONS

- **DC Volts** — 0 to 1.5/6/30/150/300/600/1500 volts
- **AC Volts (RMS and Peak-to-Peak)** — 0 to 3/12/60/300/1200 volts
- **Ohms** — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- **RF** — Peak reading demodulator supplied for use on all DC ranges
- **Zero Center** — available on all DC volt ranges with zero at mid-scale
- **Decibels** — from —10 Db to +10/22/36/50/62 based on the Dbm unit: ODb-1MW in 600 ohms
- **Impedance** — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- **Input Capacity** — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 — fully wired and calibrated, housed in handsome hammertone finish steel case, complete with MULTI-PROBE, and thorough instruction manual covering all the applications in detail.

$58.50 Net

FAST-CHECK TUBE TESTER Model FC-2



SIZE: W–14⅝" H–11¼" D–4⅜"

Model FC-2 — housed in hand-rubbed oak carrying case complete with CRT adapter

$69.50 Net

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- Checks for inter-element shorts and leakage.
- Checks for gas content.
- Checks for life-expectancy.

SPECIFICATIONS

● No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers ● No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement ● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● 41 phosphor bronze beryllium tube sockets never need replacement ● 7-pin and 9-pin straighteners mounted on panel ● Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● Compensation for line voltage variation ● 12 filament positions ● Separate gas and short jewel indicators ● Line isolated — no shock hazards ● Long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

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- ☐ Model MC-1 Mini-Check Tube Tester $39.50
  $9.50 within 10 days. Balance $6 monthly for 5 months.
- ☐ Model SRT-1 In-Circuit Rectifier Tester $29.50
  $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model TT-2 Transistor Tester $24.50
  $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter $58.50
  $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester $69.50
  $14.50 within 10 days. Balance $11 monthly for 5 months.

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Please rush the instruments checked for **a 10 day** free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is understood there will be NO INTEREST or FINANCING charges added.

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Department of EIA was the principal speaker.

ESFETA REPORTS GROWTH

The Empire State Federation of Electronic Technicians (ESFETA) welcomed its 14th affiliate to membership with the attendance of Leonard Block, president of the newly affiliated North Tonawanda group at the last meeting of ESFETA. In 1955 there were just 7 affiliated groups.

At the meeting in Syracuse the present officials were all re-elected: Robert Larsen, president; Irving Toner, vice president; George Carlson, secretary; Dan Hurley, treasurer; Frank Kurowski, sergeant-at-arms. Writes George, "I missed the meeting because our car caught fire on the Thruway and we never got there at all!"

KENTUCKY ASS'N ELECTS

The Kentuckiana TV & Radio Technicians Association (KTRTA) elected

as officers (pictured above in the usual order) at their regular meeting Ira Masden, vice president; George Leitner, treasurer; Giles Allen, president; Bud Pilkington, treasurer.

DO YOU BELONG TO A SERVICE TECHNICIANS' ASSOCIATION?

For the benefit of service technicians and their organizations RADIO-ELECTRONICS is beginning a complete list of the known televison service associations in this country and Canada. Due to the difficulty of contacting associations, our first list will necessarily be incomplete and sometimes inaccurate. Service technicians can help us put out a complete up-to-date list. If you know of any association omitted from our list, or can correct any of the old listings, please also write to: Associations Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y.

This month we start by publishing a list of known *state* associations; thereafter we will list a number of local associations each month. If there is a group near you, why not contact them? It's for *your* benefit.

To learn of the association nearest you *now*, drop a postcard to: Association Editor, RADIO-ELECTRONICS, 154 W. 14th St., N. Y. 11, N. Y.

ARIZONA
BETTER ELECTRONIC SERVICE TECHNICIANS OF ARIZONA
Box 1284
Phoenix
David Gordon, Secretary

ARKANSAS
TELEVISION SERVICE ASSOCIATION OF AMERICA
Box 542
North Little Rock
W. D. Todd, Secretary

CALIFORNIA
RADIO TECHNICIANS ASSOCIATION
Box 4085
Long Beach 4
Harry Ward, Secretary

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Wally Crusan, Secretary

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NEW TUBES and SEMI-CONDUCTORS

THIS month's releases are highlighted by a series of triode-pentode tubes designed as combination voltage and power amplifiers, plug-in silicon rectifiers as direct replacements for mercury-vapor 866's, a 24-inch picture tube for cathode-drive circuits and a miniature power amplifier tube delivering 24 watts per pair with low grid drive.

18FW6

A miniature semi-remote-cutoff pentode in a 7-pin envelope, it is the first of a series of tubes to have 100-ma heaters and is designed for use in ac–dc radios in rf and if applications.

Typical operating characteristics of this Sylvania tube are:

V_H	18
V_P	100
V_{G2}	100
g_m (μmhos)	4,100
R_P (K ohms)	250

Other tubes in this series are the 18FX6, dual-control miniature pentigrid amplifier; 18FY6, hi-mu triode double diode; 32ET5, beam power pentode; and a 35AM3, half-wave rectifier. All are packaged in a standard 7-pin

18FW6

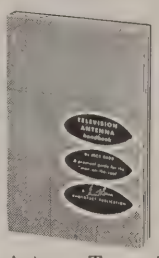
miniature envelope and are designed to be directly interchangeable with conventional 150-ma prototypes. Of course, when substituted in a series-string receiver, all the tubes would have to be changed at the same time.

6FY8, 12FY8, 25FY8, 50FY8

New miniature triode-pentode tubes combining voltage and power amplifiers. A pair of either of these types are the only tubes required in a stereo amplifier using the CBS modified simplex (two-way) circuit. (See diagram.)

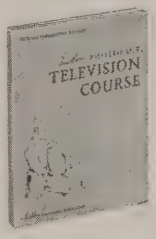
IMPORTANT NEW SAMS BOOKS

"Television Antenna Handbook"
by Jack Darr



A practical guidebook for the antenna installer and serviceman. Thoroughly covers the requirements of each reception area (primary, secondary, fringe and far-fringe). Chapters include: The TV Signal—From Transmitter to Receiver; Characteristics of Basic Antennas; Commercial TV Antenna Types; Transmission Lines; Antenna Rotators; Planning the Installation; On-Location Tests; Tools and Equipment; Towers, Masts and Guying; Roof-Top Techniques and Safety; Installing Antenna and Lead-in; Noise, UHF and Color; Unusual Installations; Servicing the Antenna System. Most complete and practical book available on the subject. Illustrated; 248 pages; 5½ x 8½"; only $3.95

"Photofact Television Course"
All-New 2nd Edition



Completely revised edition of the famous Course which has helped in the training of thousands of successful technicians. Covers the complete subject of monochrome TV in three unique study sections. The emphasis is on the practical theory and operation of receiver circuits. Each section is built around a requirement of the picture tube, until every circuit in the TV receiver is covered. The course includes step-by-step descriptions of the functions of all important circuits, supported by many schematics of actual commercial circuits. Clearly written for easy understanding. The ideal course for students, service newcomers and hobbyists. Fully illustrated; 192 pages; 8½ x 11"; only $3.95

"Video Speed Servicing" Vol. 3

Latest volume in this valuable reference manual series. Presents 456 practical troubleshooting hints that will cure hard-to-find faults in some 87 chassis of late-model TV receivers. All models are indexed by brand name, model and chassis number for quick reference. An invaluable aid for shop bench use; each hint is accompanied by an explanatory diagram or schematic. 160 pages, 8½ x 11"; only..... $2.95

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☐ "Photofact Television Course" (TV-2)
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PROFESSIONAL 55
the Ultimate
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COLUMBIA

Professional 55 . . .
Cost $28.95

This new transparent cartridge is the professional's version of the popular Columbia CD. A high-compliance model with excellent transient response, it uses a .5-mil diamond stylus and is designed for transcription turntables. Comes complete with 4 miniaturized plug-in equalizing networks for low- and high-level inputs.

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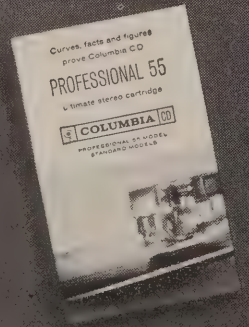

Ask for Bulletin E-331. Check the Professional 55's superiority in: linearity . . . separation . . . needle point impedance . . . low mass . . . freedom from hum and distortion . . . output level . . . and ruggedness.

YOUR OWN EARS PROVE IT

Better still. Your own ears will convince you the Professional 55 is your best investment. Ask to see and hear it at your distributor's today!

CBS ELECTRONICS
A Division of
Columbia Broadcasting System, Inc.
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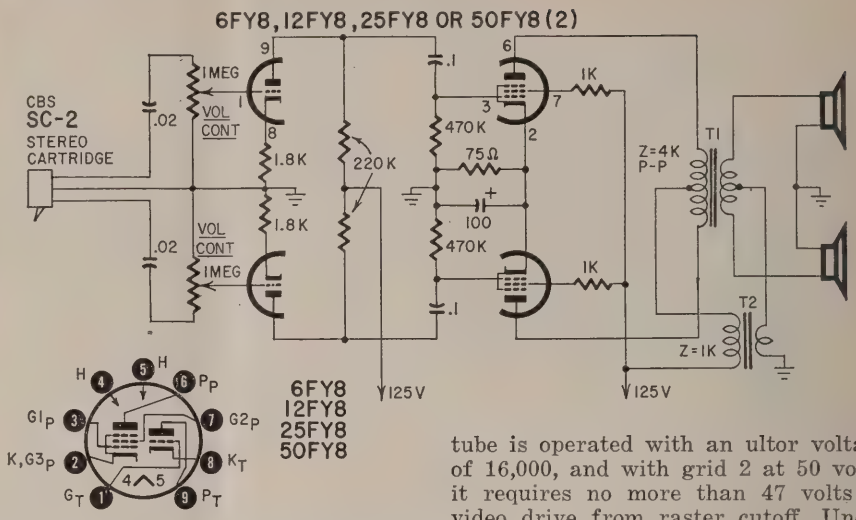


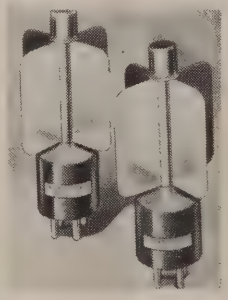
This amplifier delivers up to 3.5 watts output per channel. Secondary impedance of T1: each side of center tap equals impedance of one speaker. Secondary impedance of T2 is half the impedance of one speaker. For construction data on this type amplifier, see "Two-Way Stereo Amplifier Uses Only 3 Tubes," June, 1959, page 52.

Heater currents for these CBS-Hytron 6.3-, 12.6-, 25- and 50-volt tubes are 1.2 amps, 600, 300 and 150 ma, respectively. Typical operating characteristics are:

	Triode	*Pentode*
V_P	125	125
V_{G2}		125
V_{G1} (neg)	1.5	13.5
I_P (ma)	2.5	50
I_{G2} (ma)		10
g_m	2,000	7,000
R_L (ohms)		2,000
P_P (watts)		2.7
V_{in} (rms)	0.3	

Silicon 866 replacement

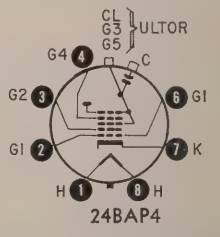
High-voltage silicon rectifier cartridges, rated at 6,400 piv at 250 ma, mounted with cooling fins on a 4-pin tube base replace mercury-vapor 866's. As well as replacing the 866's, the



2.5-volt filament transformer needed for the tube is eliminated. No warmup time is required—high voltage can be applied immediately. Heat generation is only 6.5 watts. The new unit is made by International Rectifier.

24BAP4

This 24-inch picture tube is designed for use in cathode-drive circuits. It has an electron gun that has improved cathode drive sensitivity. When the tube is operated with an ultor voltage of 16,000, and with grid 2 at 50 volts, it requires no more than 47 volts of video drive from raster cutoff. Under these conditions, the minimum ultor current at zero bias is 1 ma. The electron gun used in the RCA 24BAP4 requires no ion trap. The directly viewed tube uses magnetic deflection and low-voltage electrostatic focus. It is a rec-



tangular tube with a spherical Filterglass faceplate and an aluminized screen.

Maximum design-center ratings for this picture tube in cathode-drive service are:

$V_{ultor-G1}$ (max)	20,000
(min)	12,000
V_{G4-G1} (pos)	1,000
(neg)	500
V_{G2-G1}	64
V_{K-G1} (pos peak)	200
(pos bias)	140
(neg peak)	2
(neg bias)	0

Miscellaneous

The 7326, a 10-stage head-on multiplier phototube; the 7203/4CX250B, a forced-air-cooled beam power tube for frequencies up to 500 mc, and the 6DE4 and 17DE4, damper tubes for 110° TV receivers have been announced by RCA.

Vacuum Tube Products Co. has a new series of thyratrons that incorporate new grid and filament design to permit a 30% increase in peak anode current.

HPA-2800 and HPA-2810 are Hughes Aircraft diodes intended for uhf and microwave applications. Both have a nominal frequency cutoff of 70,000 mc at maximum back bias with a nominal zero-bias capacitance of 2.5 $\mu\mu$f.

Silicon solar-cell modules which interlock to form larger units are available from Internation Rectifier. The firm has also released a line of 1,500-piv 300-ma silicon rectifiers. END

On the Market

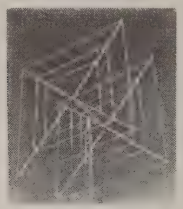
TOOL KITS with interchangeable bits for Allen hex screws and fluted-spline recessed screws are *models ZA40* and *ZF40, respectively*. Each kit comes with handle and graduated-size bits in rollup plastic tool case.—**Vaco Products Co.**, 317 East Ontario St., Chicago, Ill.

COLOR AND 110° ADAPTER for picture-tube tester, *model CA-200*. Adapts company's *model V-200* picture-tube tester and reactivator for testing each gun of color tube, includes new heater voltages, 2.34, 2.68, 8.4.

Tests new short-neck 110° tubes.—**Vis-U-All Products Co.**, 640 Eastern Ave., S. E., Grand Rapids 6, Mich.

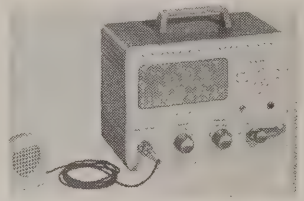
VHF TV YAGI ANTENNA, *Power Pix*. Full gain on channels 2 through 13. "Hairpin" driven element gets broad-band frequency characteristics with gain of colinear antenna. Polystyrene insulators have dual moisture barrier with 3½-inch leakage path.—**Winegard Co.**, 3000 Scotten, Burlington, Iowa.

3-BAND CUBICAL QUAD ANTENNA, *model MK III Deluxe Quad*. 10, 15, 20 meters.



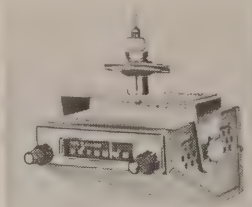
Gain 10 db, 10 and 15 meters; 8 db, 20 meters. Turning radius 9.5 feet. 27 lbs. Boom 2 inches x 8 feet long.—**Cubex Co.**, Altadena, Calif.

CITIZEN'S BAND KIT, transceiver *model CB-1*. Operates on any of 23 channels with crystal



of choice (supplied), 5 watts input to antenna. Receiver superregenerative detector. 4-inch speaker. Audio output 1 watt. Operates off 117 volts 50/60 cycles, or with available auto radio vibrator supplies 6 or 12 volts. Microphone supplied.—**Heath Co.**, Benton Harbor, Mich.

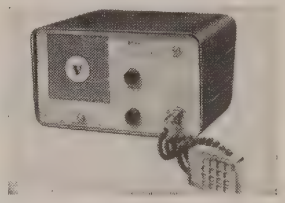
TRUCK RADIO. Universal auto–boat–truck *model Karadio*.



6 tubes, tone control, available for 6- or 12-volt systems. Hangs from antenna-mounting hole in roof, may be mounted in or under dashboard. — **American Television & Radio Co.**, 300 E. 4th St., St. Paul, Minn.

CITIZENS' BAND RADIO transceiver *model ED-27* for 27-mc band. 10 tubes; transistor power supply. Works on 110 volts ac and 6 or 12 volts dc for mobile. Receiver double-conversion superhet, crystal-controlled though tunable without crystal. Selectivity 6 db down at 5 kc, sensitivity 0.1 μv, audio output 4.5 watts into self-contained

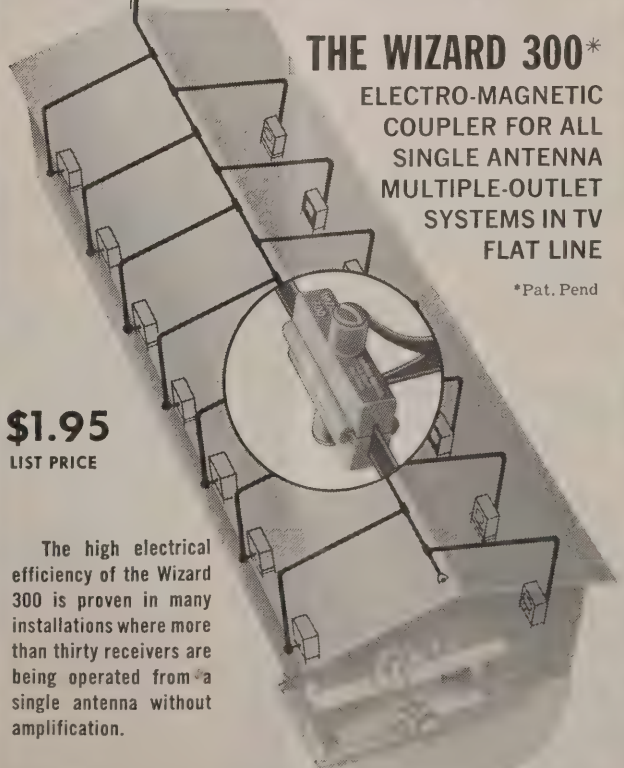
(*Continued on page* 106)



YOU CAN ALSO DO THE BIG JOBS WITH WIZARDS

HOME – 7 Outlets – One Antenna – No Amplification: Residence of Bob Barker, MC of the popular daytime NBC show Truth Or Consequences.

HOTEL – 120 Outlets–One Antenna–One Amplifier: The Montecito – 6650 Franklin, Hollywood, California.



THE WIZARD 300*

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*Pat. Pend

$1.95 LIST PRICE

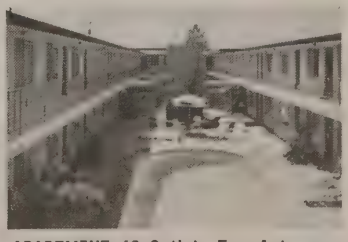
The high electrical efficiency of the Wizard 300 is proven in many installations where more than thirty receivers are being operated from a single antenna without amplification.

Information on any of the above jobs and a brochure covering Wizard System installations is available. Write Dept. RE89.

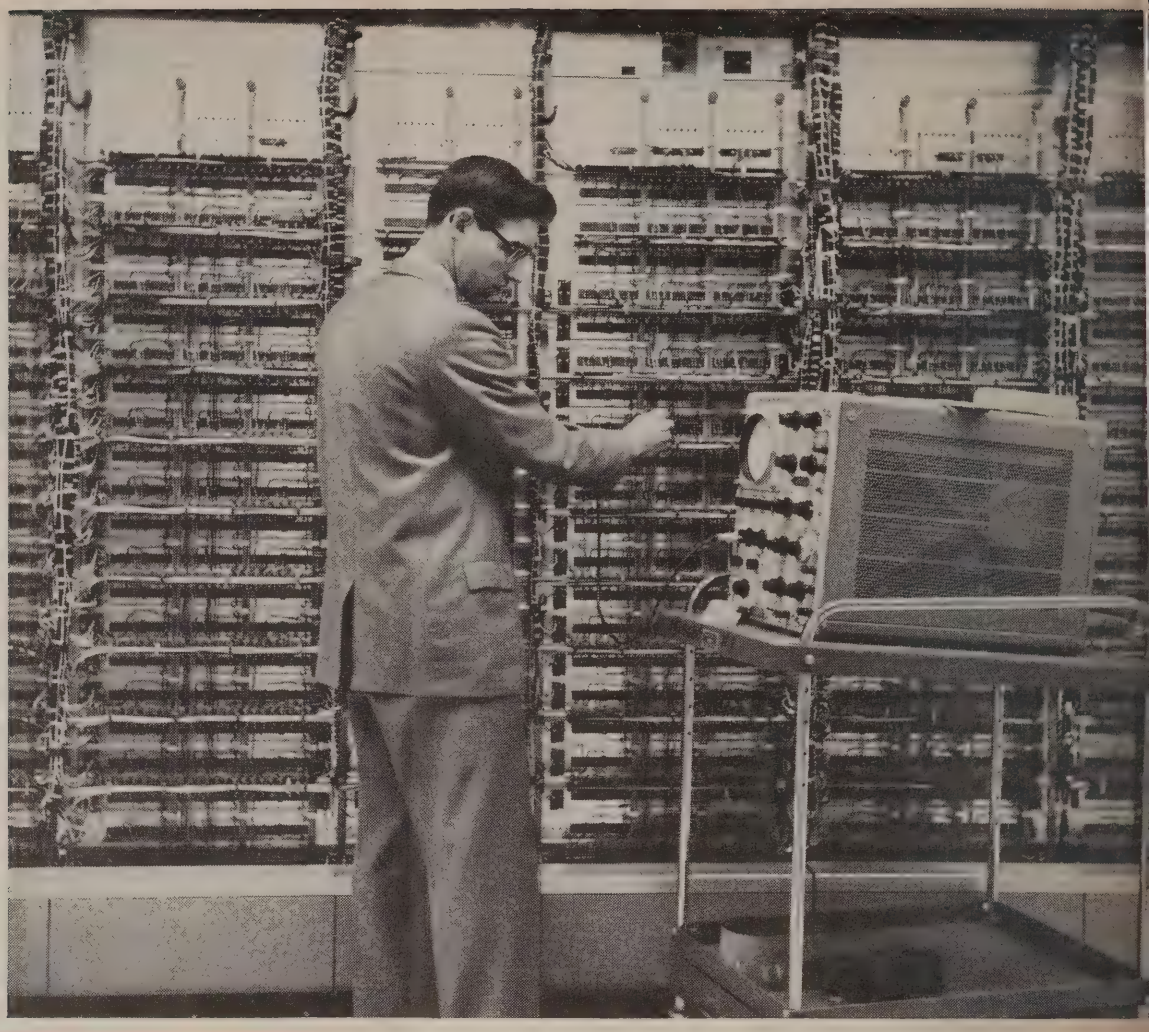
CHARLES ENGINEERING, INC.
6053 Melrose Avenue · Los Angeles, California

HOUSING PROJECT – 2,549 Wizards Installed To Date: L.A. Housing Authority, Los Angeles, California.

APARTMENT – 39 Outlets–One Antenna –No Amplification: The Del Rio – 10236 Old River School Road, Downey, Calif.



APARTMENT–48 Outlets–Two Antennas (24 Outlets each) – No Amplification: The Paramount Riviera – 12447 Paramount Blvd., Downey, California.



Watching oscilloscope, Bill Wilkerson tests SAGE computer circuitry.

Adjusting SAGE computer operating console.

Bill Wilkerson instructs Field Engineers on new computer program.

How far can you go in electronics... without a degree?

Three years ago, young Air Force veteran William H. Wilkerson set out to find a career in electronics, but he had no industrial experience and no engineering degree. Today, he has a solid electronics education, he is supervising the maintenance of a highly advanced electronic computer, and his future is bright. Here's how it happened...

SOUGHT ELECTRONICS CAREER

"I was anxious to go to college when I left the service in 1956," recalls Bill Wilkerson. "The Air Force had given me some fine training in electronics, enough to arouse my interest and make me want to learn a lot more. An engineering education seemed to be the answer, but family responsibilities made college impossible.

"I still wanted to work in electronics, however, so I started looking into technician jobs. Most big companies offered me no more than a seat at a test bench eight hours a day —dull, routine work that provided little or no opportunity to learn and grow. All the interesting assignments, it seemed, called for a college degree. Then I had an interview with IBM and found just what I was looking for in the SAGE Field Engineering Program."

WHAT IS SAGE?

SAGE is a vital part of our country's air defense. To help guard against surprise aerial attacks, SAGE partitions America into several defense sectors. At the heart of each sector is one of the fastest and most reliable electronic computers in the world. This computer receives radar data from many points, checks this against known air traffic in its sector, and makes it possible for Air Force operators manning the computer to identify immediately all flying objects as friendly or hostile. If need be, the computer can also guide a BOMARC missile to an enemy target.

THOROUGH COMPUTER TRAINING

On joining IBM, Bill Wilkerson was given 20 weeks' computer training as a Field Engineer. He learned how to maintain the various electronic units used in a SAGE computing system, how the SAGE computer itself helps diagnose and locate problem areas, and how to make fast, precise repairs without interfering with computer operation. "It was an excellent education—both in the theoretical and practical aspects of electronics," he says. "Furthermore, you have plenty of opportunities to keep up with new developments in this fast-changing field. After assignment to a SAGE site, for example, you may take courses—during regular working hours—on such subjects as improved output methods or new magnetic 'memory' devices. You may also be selected for additional training to learn the total functioning of a large-scale electronic data processing system."

ASSIGNMENTS ROTATED

Bill Wilkerson is now a Field Engineering Group Supervisor at a SAGE site. "I help my Group Manager keep the computer in top working condition," he explains. "Together, we provide technical supervision to the Field Engineers in our group and schedule daily maintenance checks to spot computer problems before they develop into breakdowns. An important part of my job is to make up daily assignment sheets, carefully rotating responsibilities so that each Field Engineer moves from one computer unit to another. This 'cross-training' gives each man a chance to become familiar with all the parts of a large-scale computing system and helps him add to his general electronics knowledge."

RAPID ADVANCEMENT

"When I was first interviewed, I was told that IBM promotes from within," Bill Wilkerson says. "I've found this to be true. In the SAGE computer program, you begin as a Units Field Engineer. Then, depending on your abilities, you can advance rapidly to Systems Field Engineer, Group Supervisor, Group Manager, and on up the line. Every employee receives frequent career counseling to review his progress and to chart his future. In this Company, there are plenty of opportunities for the man who wants to grow and is willing to apply himself."

Bill Wilkerson cites his own career as an example. Since joining IBM three years ago, he's had several promotions, culminating in his present supervisory post. "It's a wide-open field," he says.

A BRIGHT FUTURE

Although other areas for promotion are open to him, Bill Wilkerson would like to stay in technical management because, as he says, "Frankly, I hardly believed back in '56 that a man like myself without a college education could go so far so fast, have still higher goals—and find such solid help in reaching them."

* * * *

If you have a minimum of 3 years' technical schooling—or equivalent experience—you may be eligible for 20 weeks' training as a computer Units Field Engineer. While training, you receive full pay plus living allowance.

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WHAT THE "EDU-KIT" OFFERS YOU

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction, servicing, basic Hi-Fi and TV repairs, code, FCC amateur license requirements.

You will learn how to identify radio symbols, how to read and interpret schematics, how to mount and layout radio parts, how to wire and solder, how to operate electronic equipment, how to build radios. Today it is no longer necessary to spend hundreds of dollars for a radio course. You will receive a basic education in radio, worth many times the small price you pay, only $22.95 complete.

THE KIT FOR EVERYONE

The Progressive Radio "Edu-Kit" was specifically prepared for any person who has a desire to learn Radio. The "Edu-Kit" has been used successfully by young and old in all parts of the world, by many Radio Schools and Clubs in this country and abroad. It is used for training and rehabilitation of Armed Forces Personnel and Veterans throughout the world.

The Progressive Radio "Edu-Kit" requires no instructor. All instructions are included. Every step is carefully explained. You cannot make a mistake.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore, you will construct radio circuits, perform jobs and conduct experiments to illustrate the principles which you learn.

You begin by examining the various radio parts included in the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set, you will enjoy listening to regular broadcast stations, learn theory, practice testing and troubleshooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

In order to provide a thorough, well-integrated and easily-learned radio course, the "Edu-Kit" includes practical work as well as theory; troubleshooting in addition to construction; training for all, whether your purpose in learning radio be for hobby, business or job; progressively-arranged material, ranging from simple circuits to well-advanced topics in Hi-Fi and TV. Your studies will be further aided by Quiz materials and our well-known FREE Consultation Service.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hookup wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to the F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, and a High Fidelity Guide and Quiz Book: Everything is yours to keep.

J. Statkis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

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The Progressive Radio "Edu-Kit" has been sold to many thousands of individuals, schools and organizations, public and private, throughout the world. It is recognized internationally as the ideal radio course.

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The high recognition which Progressive "Edu-Kits" Inc., has earned through its many years of service to the public is due to its unconditional insistence upon the maintenance of perfect engineering, the highest instructional standards, and 100% adherence to its Unconditional Money-Back Guarantee. As a result, we do not have a single dissatisfied customer throughout the entire world.

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speaker. Variable squelch. Transmitter 5 watts input to final plate, transmit indicator light, microphone push-to-talk switch for receive–transmit. Supplied with short-range antenna, crystal for 1 Citizens' band channel. Working range from 1 to 15 miles, depending on terrain and antenna. Extra crystals and longer-range antennas available. **—Vocaline Co. of America, Inc.,** Old Saybrook, Conn.

TAPE-HEAD DEMAGNETIZER, *model AR-294* has 3 sets of interchangeable pole pieces

to provide access to any tape head. Works on 117 volts ac.—**Argonne Electronics Mfg. Corp.,** 165-11 South Road, Jamaica 33, N. Y.

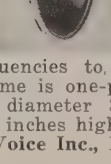
LOUDSPEAKER *models D8LA* and *D12LA* have response 30–16,000 cycles, handle up to 20

watts audio power. Impedance 8 ohms.—**Utah Radio & Electronic Corp.,** 1124 E. Franklin St., Huntington, Ind.

SPEAKER LINE, *models LE8, LE10,* and *LE30,* Linear Efficiency series, 8-inch extended-

range driver (shown), 10-inch woofer, high-frequency driver. Speakers designed for mounting from front of baffle. *Minigon* bookshelf version of *Metregon* folded-horn and curved-reflector tweeter. — **James B. Lansing Sound, Inc.,** 3249 Casistas Ave., Los Angeles 39, Calif.

30-INCH WOOFER, *model 30W,* cone of polystyrene foam moving as a true piston. Repro-



duces frequencies to below 18 cycles. Frame is one-piece casting. Cone diameter 30 inches. Cabinet 54 inches high, 32 wide. **—Electro-Voice Inc.,** Buchanan, Mich.

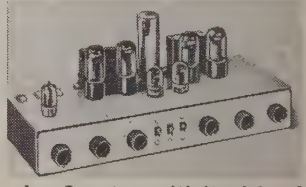
DYNAMIC MICROPHONE *Grampian model DP4,* slim-line design supplied in desk holder, readily removed for use with

floor or table stands or hand use. Response 50–15,000 cycles, choice of 25, 600 or 50,000 ohms. ½ lb.—**Tandberg of America, Inc.,** 8 Third Ave., Pelham, N. Y.

PA AMPLIFIERS, *Carnival* 5-watt ac unit has 4- and 8-ohm

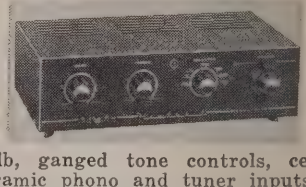
outputs, microphone and phono–tuner inputs with separate gain controls allowing mixing. *Model PA 30/60* PA unit (shown) includes 2 microphones, 1 phono input, 3 gain plus treble and bass controls. Five output impedances including constant-voltage tap. Powered by 117 volts ac or 6 or 12 volts dc.—**Radio Shack Corp.,** 730 Commonwealth Ave., Boston 17, Mass.

ECONOMY AMPLIFIER KIT, *model CS-12,* stereo power amplifier and preamp with controls. Ganged bass, treble, loudness. Stereo balance, reverse, mono selector. Loudness switch. 12 watts rated output per channel. Response 20–20,000



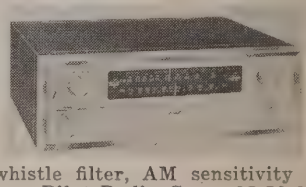
cycles. Input sensitivity 0.3 volt. —**Arkay Radio Kits, Inc.,** 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y.

STEREO AMPLIFIER KIT, *model SA-3,* economy unit, has channel and phase-reversing switches, 3 watts output per channel, distortion under 3%, response 50–20,000 cycles ±1



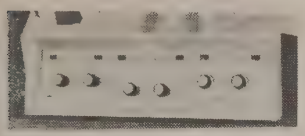
db, ganged tone controls, ceramic phono and tuner inputs. 4-, 8-, 16-ohm outputs.—**Heath Co.,** Benton Harbor, Mich.

STEREO FM–AM TUNER, *model 580,* two independent tuners. Both oscillators temperature-compensated, 1-mc wideband FM detector, FM sensitivity 1.5 μv, AM rf stage, 10-kc



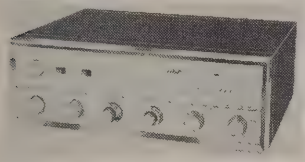
whistle filter, AM sensitivity 3 μv.—**Pilot Radio Corp.,** 37-50 36 St., Long Island City 1, N. Y.

STEREO KITS, *Model SA-40* complete amplifier 20 watts per channel. Bass, treble, balance, loudness controls. Rumble, input, mode, loudness, speaker-selector switches. Tape-head input and choice of 2 tape equalization curves. *Model ST-45* stereo FM–



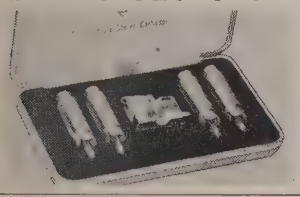
AM tuner matches SA-40 stereo amplifier. Also available as factory-wired units.—**PACO Electronics Co., Inc.,** 70-31 84th St., Glendale 27, N. Y.

STEREO AMPLIFIER–PREAMP, *model 240.* 15 watts per channel, tone controls operable locked together or adjustable



for each channel separately, speaker-selector switch, 2 phono inputs and switch positions labeled for changer and turntable separately, tape head input, automatic shutoff controlled by changer, loudness control and switch, hum and noise down 80 db.—**Pilot Radio Corp.,** 37-50 36 St., Long Island City 1, N. Y.

STEREO PHONO CARTRIDGE, *Professional 55.* High-compliance version of *model CD* (for changer use) is intended for transcription arms. Tracking force 1.5 grams, diamond stylus 0.5-mil radius, output 0.4 volt at 5 cm/sec. Channel separation 20 db, response 20–15,000 cycles ±3 db. Supplied with 2 miniaturized plug-in networks to equalize output for low- and high-level phono inputs.—**CBS Electronics,** Danvers, Mass.



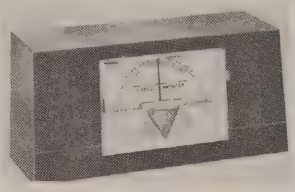
STEREO MAGNETIC CARTRIDGES, *series VR-22.* Similar in appearance to G-E *Golden Classics. VR-225* has 0.5-mil stylus for transcription arms; *VR-227,* 0.7-mil diamond for changers. *VR-225* response 20–20,000 cycles ±3 db, channel separation up to 30 db, lateral

compliance 4 × 10^{-6} cm/dyne, vertical 2.5 × 10^{-8}, tracking force 2 to 4 grams.—**General Electric Co.,** West Genesee St., Auburn, N. Y.

HIGH-OUTPUT STEREO phono cartridge line. 3 models, *70TS, 74TS, 76TS-TB.* Replacement, original-equipment and mono-to-stereo conversion units

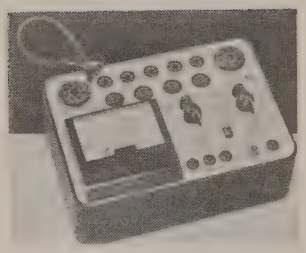
for various physical mountings in changer arms. Output 2 volts, response 50–10,000 cycles, separation 20 db, stylus pressure 10 grams.—**Astatic Corp.,** Conneaut, Ohio.

STEREO BALANCE METER *model Stereo-Monitor.* Inserts at output of stereo amplifiers, reads balance or imbalance of



stereo signals. Rack or panel mounting or in various wood cases.—**Park Products Co., Inc.,** 4901 Perkins Ave., Cleveland 3, Ohio.

VTVM–TUBE–TRANSISTOR TESTER, *model 820.* Tube Caddy Pal tests transistors, picture and receiving tubes. Is also a 10-megohm input vtvm. 4 dc voltage ranges 1.5 to 750. Measures resistance to 100 megohms



in 3 ranges. Consumes 15 watts at 117 volts ac.—**Hickok Electrical Instrument Co.,** 10514 Dupont Ave., Cleveland 8, Ohio.

AC AMMETER measures current drawn by radios, TV sets,

other appliances. *Model 307* has 5 ranges from 1 to 25 amps. Built-in transformer. Using *model 10* clamp-on, ammeter ranges are extended to 300 amps. Black molded case approximately 3 x 4 x 1¼ inches. —**Triplett Electrical Instrument** Co., Bluffton, Ohio. END

All specifications on these pages are from manufacturers' data.

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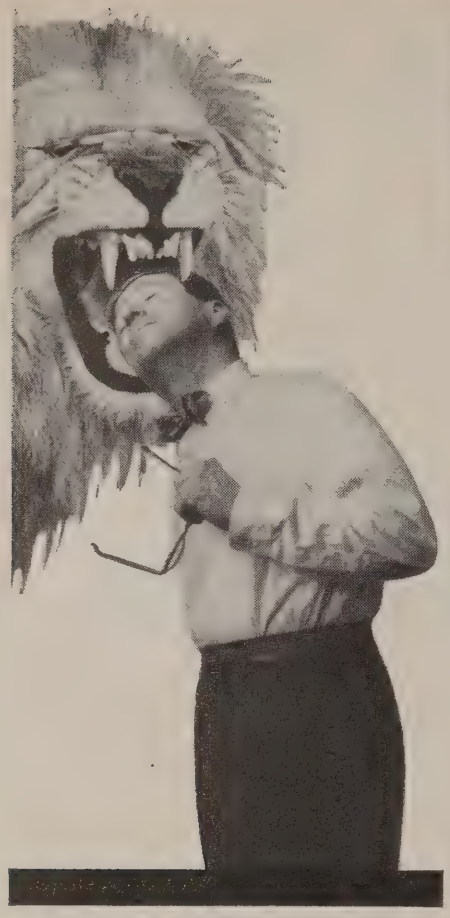

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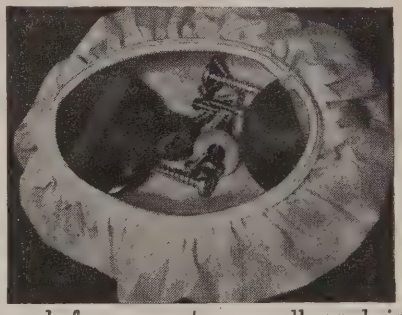
If you want to examine the point of a phonograph needle and don't have a needle-inspection microscope, you can use the viewfinder on a small folding camera. Just hold the needle close to the small lens in the front of the finder and look in at the top. You will find that the viewfinder makes a powerful magnifying glass for examining tips of recording and playback needles.

When using the viewfinder on the larger folding cameras, it may be necessary to unscrew the front lens and hold it in your hand to bring the needle into focus. This is not necessary with vest-pocket models. In either case, shine a strong light on the needle tip while examining it.—*Arthur Trauffer*

BOWL-COVER SERVICE AID

My toolkit for house calls contains, among other things, several sizes of plastic bowl covers. They come in mighty handy as bags for holding screws, knobs and other hardware removed from a set, as well as being handy slip-on protective covers for guarding against accidental speaker-cone punctures when transporting a chassis to the shop for repair. I find them very useful and would like to pass this helpful hint along to fellow technicians encountering such service problems.—*J. A. Conrad*



AC–DC TUBE SAVER

To reduce the possibility of burnt-out tube heaters in series-string equipment, try increasing the value of the series resistor by about 10%. This reduces the surge through the cold heaters that does the damage when the set is turned on.—*N. Schvedman*

45-RPM CHANGER

If you have a 45-rpm record changer and are having trouble with noise, needle-talk, distortion or scratch, there may be an easy solution. Tape a nickel

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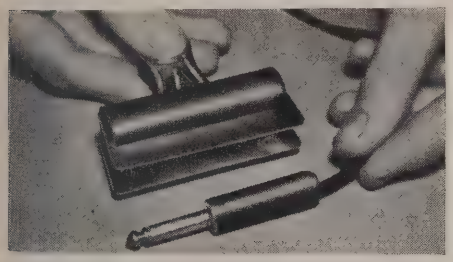
to the rear end of the pickup arm. In this way, you reduce stylus pressure. After all, noise and scratch are in the bottom of the groove and the music is in the sides. Reducing the pressure also lengthens the life of the stylus and your records.—*Lee Maggs*

CLAMP SAVES PLUG

Ever accidentally step on a phone plug and feel its bakelite handle crush under your weight? Why let a costly



accident such as this happen when you can easily prevent it by slipping a large paper clamp over the plug? Other types of electrical connectors can be protected like this, too.—*Scott Mack*

HANDY FILE

Often at the bench or in the field you want to dress up a soldering job but don't have a file handy. Also solder will clog a file and make it lose its effectiveness. An excellent, cheap substitute for a metal file is an emery board. They are available in packs of 10, for a penny apiece, at any drug or variety store. Try using one next time you have a mike or phone plug you want to dress up after soldering.—*J. Burton Burnett*

END

50 Years Ago

In Gernsback Publications

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Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In August, 1909, *Modern Electrics*

The Nauen Wireless Plant.
How to Make a Polarized Relay, by H. W. Secor.
Musical Wireless Receiver.
A New Type of Wireless Transformer, by A. Press.
Wireless Dirigible Torpedo.
New Telefunken System, by The Berlin Correspondent.
Airship Run by Wireless.
Method of Testing Short Circuited Condensers, by I. Wolff.
A Novel Detector, by D. C. Spooner.
Detector Construction, by L. Spangenberg.
New French Wireless Apparatus, by A. C. Marlowe.
Construction of a Relay for Converting Loop Antenna to Straightaway, by A. C. Austin, Jr.
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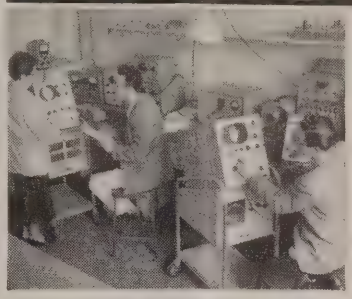
TELEVISION



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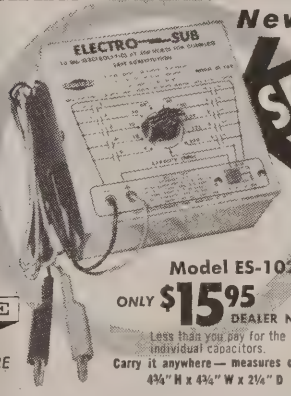

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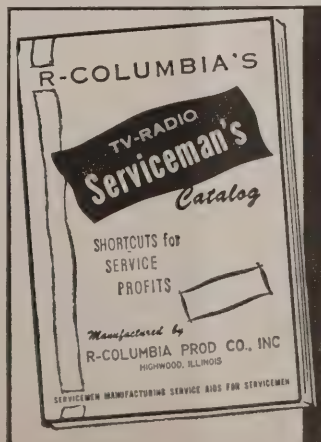

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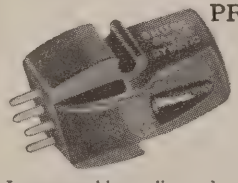

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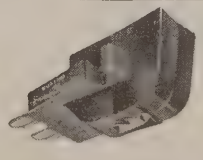

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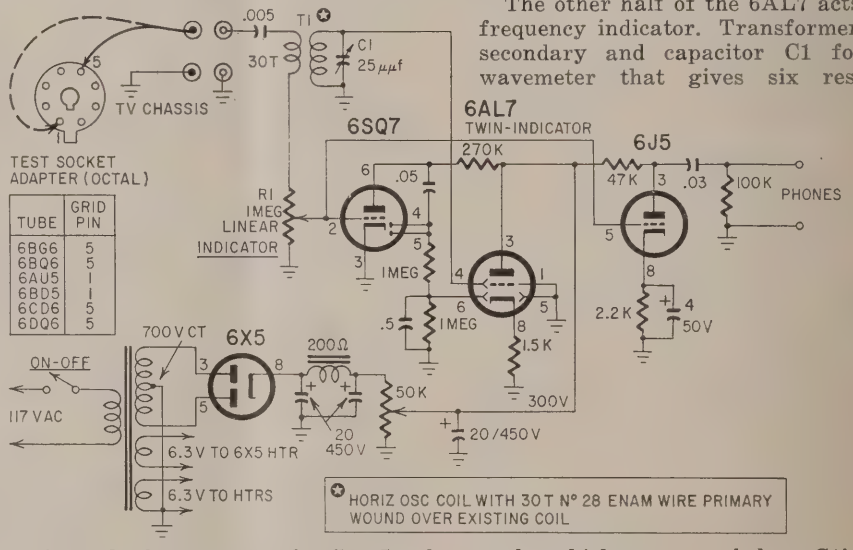
This simple instrument checks for proper frequency and intermittent horizontal oscillators in TV sets. The unit is an in-circuit tester. An octal test-socket adapter for the horizontal output tube, tapped at the grid, is used for horizontal frequency takeoff. Leads should be no more than 5 feet long, and coax or shielded cable should not be used. The 6SQ7 rectifies and amplifies the horizontal frequency, giving a minimum reading on one side of the 6AL7.



TUBE	GRID PIN
6BG6	5
6BQ6	5
6AU5	1
6BD5	1
6CD6	5
6DQ6	5

A minimum reading, obtained by rotating R1, usually falls around the center of the pot's range. This position is marked and compared to future readings to detect faulty low-output oscillation.

The other half of the 6AL7 acts as a frequency indicator. Transformer T1's secondary and capacitor C1 form a wavemeter that gives six resonant peaks which are recorded on C1's dial. If the frequency of a set is off, the peaks fall at different points.

The 6J5 is a horizontal amplifier and provides for audio detection of the horizontal frequency.—*Morris Lieberman*

STAIRCASE GENERATOR

Staircase waveforms are used extensively, for example, when testing transistors. The complete family of characteristic curves of a transistor can be displayed on a cathode-ray tube with the input voltage in abcissas, the input current in ordinates and the control current as a parameter.

The feed voltage is a sawtooth waveform, easily produced by conventional means. The control current, however, must be a staircase waveform with perfectly horizontal and equally spaced steps. Fig. 1, which appeared in *Radio und Fernsehen,* shows a staircase generator. It uses two limiter tubes controlled by sinusoidal 60-cycle signals with a 45° phase difference. The outputs of the four sections are four rectangular waves. By adjusting the

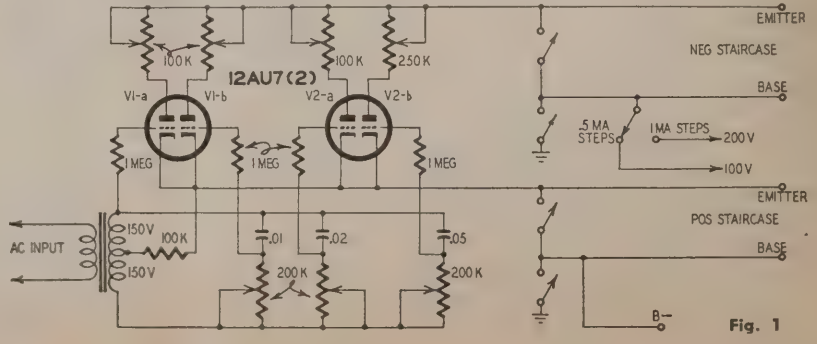


Fig. 1

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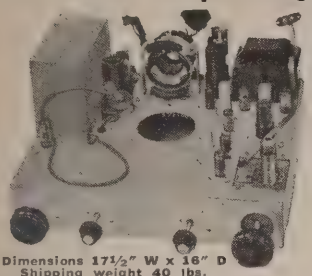

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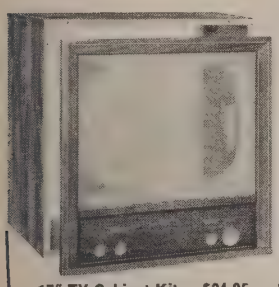

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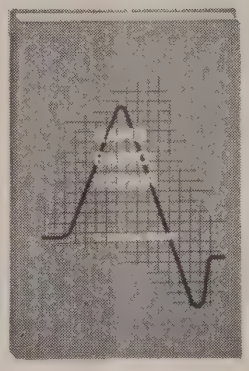

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load resistances of the tubes, the current amplitudes of the first three signals are set at 1 ma and the amplitude of the fourth signal is adjusted at 0.5 ma. In this way we get seven steps at 0.5-ma intervals (Fig. 2).

The staircase generator is normally fed 100 volts B plus. If this value is increased to 200 volts, we will get seven steps at 1-ma intervals. In any case,

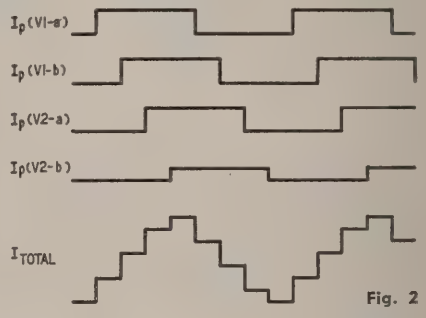


Fig. 2

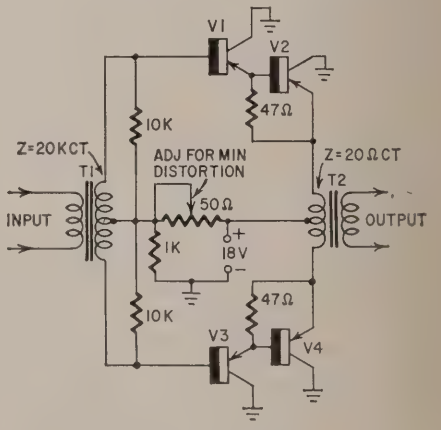
the 100 or 200 volts B plus must be regulated for accuracy.

A negative staircase is obtained in the anode circuit. A positive staircase could be obtained in the cathode circuit. In actual equipment a combination of switches allows you to use only a restricted number of steps or to maintain the current at a fixed value corresponding to one of these steps.—*A. V. J. Martin*

15-WATT TRANSISTOR AMPLIFIER

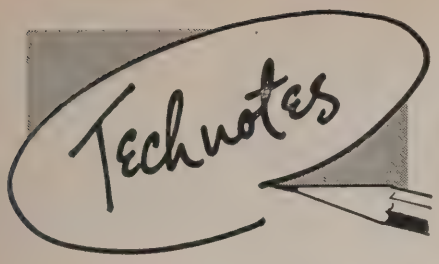
Outside of four power transistors, few parts are needed to build this unit. At 10 watts out (15 watts is the amplifier's maximum rating) power gain is 26 db. Frequency response, down 3 db at 40 and 18,000 cycles, is dependent on the quality of the transformers.

V1,2,3,4- 2N376-A, 2N351-A, OR 2N350-A



Harmonic distortion at 1,000 cycles is less than 1%. A suitable output transformer is the Stancor TA-14 rated at 10 watts—it has a 24-ohm center-tapped primary. Another useful unit is Lafayette Radio's TR-94—also rated at 10 watts—use the 24-ohm primary. The schematic shows a battery power supply. However, a well filtered dc supply could also be used. V1, 2, 3 and 4 should be identical types.—*Motorola Semiconductor Spec Sheet*

END



HALLICRAFTERS B1400

In this chassis and some other types using a horizontal deflection system similar to that shown in the diagram, a peculiar form of horizontal instability occurred. Certain sections of the picture would jitter at irregular intervals, both in time and place, with an accompanying dark spot on the picture.

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RCA T100, T120, T124

An annoying hum in the sound of one or more channels, similar to that of bad filter capacitor or intercarrier buzz, in these split-carrier models is often caused by the local oscillator being out of range of the fine-tuning control. Since the sound section uses an ordinary discriminator without any limiter stage, we can see how AM can easily creep in.

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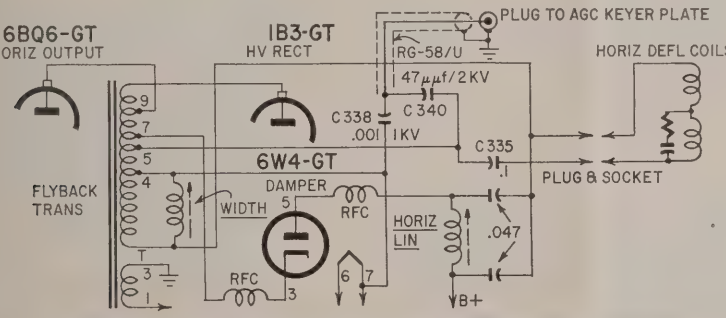

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At Lowest Prices

10BP4	$ 7.95	17BP4	$ 9.95	21AMP4	$15.75
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14B/CP4	9.95	17GP4	17.60	21AUP4	15.75
16DP4	12.00	17HP4	12.50	21EP4	13.50
16EP4	12.75	17LP4	11.50	21FP4	14.50
16GP4	14.50	17QP4	9.95	21WP4	14.00
16KP4	9.95	17TP4	17.00	21YP4	14.50
16LP4	10.95	19AP4	16.00	21ZP4	13.50
16RP4	9.95	20CP4	13.50	24CP4	23.50
16WP4	12.00	20HP4	14.50	24DP4	24.50
16PT4	9.95	21AP4	22.10	27EP4	39.95
17AVP4	12.50	21ALP4	15.75	27RP4	39.95

1 year warranty

Aluminized Tubes $5.00 more than above prices. Prices include the return of an acceptable similar tube under vacuum. These tubes are manufactured from reprocessed used glass bulbs. All parts and materials including the electron gun are brand new.

ALL PRICES FOB CHICAGO, ILLINOIS. Deposit required, when old tube is not returned, refundable at time of return. 25% deposit required on COD shipments. Old tubes must be returned prepaid. Tubes shipped Rail Express.

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A "Twin" to the SENCORE TRC4 Transistor Checker

See other SENCORE ads in this issue.

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Here is a complete isolated power supply especially designed to replace batteries during repair time of all transistor radios.

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★ Provides 100ma constant and 200ma on peaks
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$17.95
DEALER NET

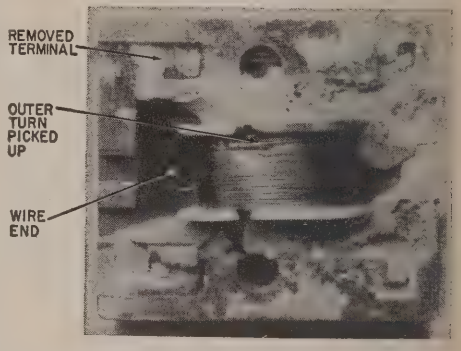
SERVICE Instruments Corp.
121 Official Road, Addison, Ill.
AT LEADING PARTS DISTRIBUTORS

settings. However, the correct setting of the trimmer is where you get maximum sound and good picture quality. If you have maximum sound, but a poor picture, screw the trimmer in farther and see if you hit another point where you get good sound and picture. When making these adjustments, set the fine-tuning control at the center of its range to allow for future oscillator drift.—*G. P. Oberto*

RECORDER HEAD REPAIR

Many erase, record and reproduce tape recorder heads can be repaired. All that is needed are spare time and a magnifier in addition to the usual shop tools.

The photograph shows an erase head that has been opened. One terminal lug was removed because the wire leading to it had corroded. Fortunately, the



wire led to the outer layer of the coil. The outer turn was picked away, having been pushed underneath the coil. It will be brought up to the front slot or opening and cemented before it is soldered to the terminal lug again. The cement holds the wire in place during soldering.—*Lawrence Shaw*

CASCODE RF STAGE

On all TV receivers using a cascode rf stage (6BQ7, 6BZ7, 6BK7), if the tube is shorted always look for a charred voltage isolating resistor—usually between 470 and 1,500 ohms—in the second half of the tube's circuit. This is a must to check after a bad tube is found, if locals come through fairly well and semi-locals far below normal. —*W. G. Eslick*

END

"Ten bucks to fix a ghost!"

PATENTS

ELECTRONIC PHASE SHIFTER

Patent No. 2,859,342

Victor A. Misek, Nashua, N. H.
(Assigned to Raytheon Mfg. Co., Waltham, Mass.)

In a tetrode, screen-grid current is controlled by *plate* and *control grid* voltages (Figs. 1-a and 1-b). The current *rises* as the grid voltage goes more positive, but *falls* with increasing plate voltage. This out-of-phase effect is used here.

In Fig. 2 the ac signal is applied to the plate through capacitor C and to the control grid through resistor R2. The dc voltages on plate and grid are adjusted as required to cancel screen output with the alternating-current signal applied.

Once balanced, the *plate* effect will predominate if R1 is increased. On the other hand, the

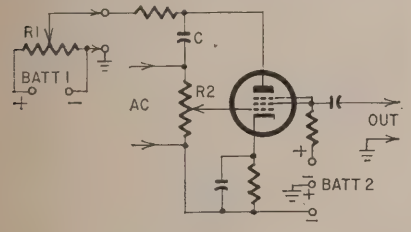


Fig. 2

grid effect will be larger if R1 is reduced. This becomes the *phase control*, because in one case the screen output will be *in phase* with the signal, and in the other it will be *out of phase*.

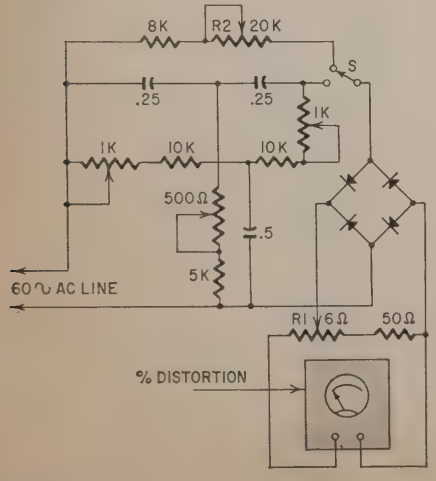
This circuit can energize reversible motors which depend on currents that are in phase or out of phase.

POWER-LINE DISTORTION METER

Patent No. 2,875,403

Roswell W. Gilbert, Montclair, N.J.
(Assigned to Daystrom, Inc., Murray Hill, N. J.)

This describes an accurate and practical ac power-line distortion measuring instrument. Briefly, the 60-cycle fundamental is trapped by a parallel-T network and the remaining harmonics are rectified and measured.



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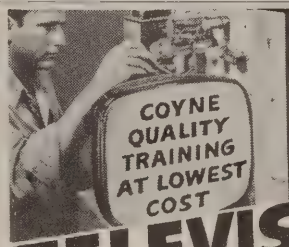

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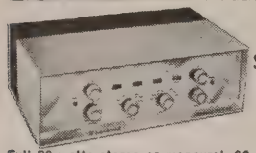

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Full 28 watts stereo or monaural, 60 watts peak • 14 watts each channel • reverse stereo • balance control • two-channel gain control • full range bass and treble controls • IM distortion, 4 to 1 • harmonic distortion, 1% 30-20,000 cps • dual pre-amp 2V output jacks • speaker outputs, 4, 8, 16, 32 ohms • response, 20-20,000 cps • push-pull EL84 Williamson circuit.

Wired and tested $99.95 Easy-to-build Kit $64.95

ARKAY ST-11 AM-FM STEREO TUNER

Here, for the first time, is an AM•FM STEREO Tuner within the reach of every audiophile. Unmatched by units costing twice the price, the ST-11 is two distinct receivers in one featuring 4 μV. for 20 db quieting. Variable AFC. Single front panel switch controls AM, FM or STEREO selection.

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ARKAY SPA-55 STEREO AMP

Two 27½ watt distortion-free hi-fi amplifiers for stereo. Or use as 55 watt monaural amplifier.

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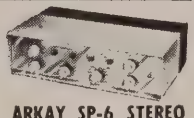

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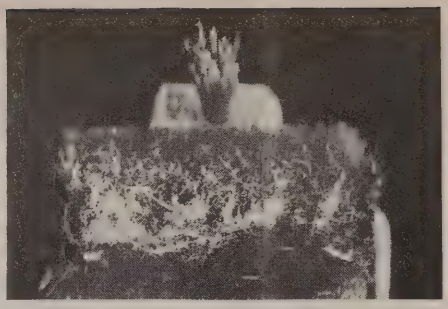

Stops record damage!

Do you know all your records contain dust in every inch of groove? This unretouched photomicrograph, courtesy of Wireless World (London), shows how much is removed by one use of the ESL Dust Bug. If not removed, these particles cause noise (especially on stereo records), and also inflict permanent damage upon valuable records and styli.

The only safe, effective method of cleaning records is the ESL Dust Bug, acclaimed by more than 200,000 delighted users throughout the world. It's easy, too—it cleans automatically while the record is being played. Only $5.75 complete (record changer model only $4.75).

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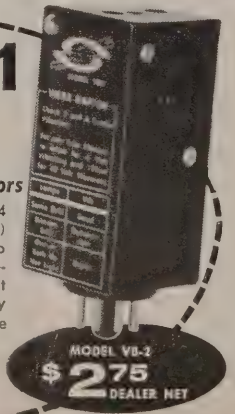

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121 Official Road, Addison, Illinois

See other SENCORE ads in this issue.

PATENTS *(Continued)*

The device is calibrated using 180 cycles, since distortion in the field usually shows up mostly in the third harmonic of the power-line frequency. R1 is set so the meter reads full scale with 11 volts of 180-cycle signal applied to the input and switch S depressed so the T-network is in the circuit. Then 110 volts 60 cycles is applied to the input and R2 is set for full-scale deflection of the meter.

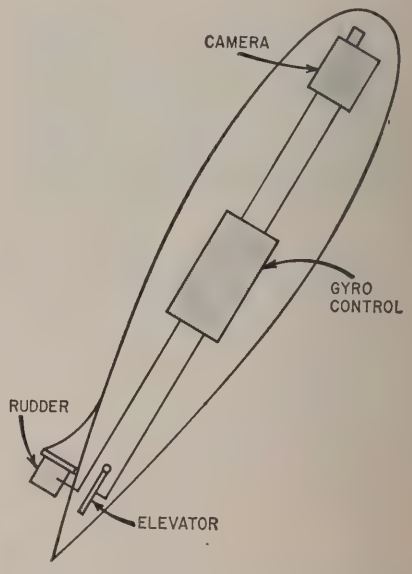
Vernier resistance adjustment is available in the arms of the T-network. This is required to compensate for possible error in the fixed capacitors. R1 and R2 may be readjusted in the field if necessary.

GUIDED LENS

Patent No. 2,869,803

James D. McGee, Ealing, London
(Assigned to Electric & Musical Industries, Ltd., Hayes, England)

This is about a controlled lens mounted on a guided missile to keep the target image in view at all times. Ordinarily the missile may change



direction from time to time during flight, correction being made continually by a gyro. These changes tend to blur the image transmitted by the TV camera.

A variable-angle camera lens is coupled to the gyro. When the gyro moves (to correct for error in missile flight), an opposite movement is imparted to the lens. Thus the picture remains in view and steady no matter how the missile may move around during its flight. This gives a steady image. END

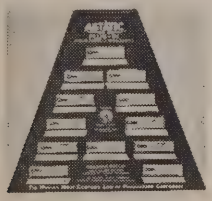
"If I buy one now, will I be able to add stereo later?"

BUSINESS and PEOPLE

Sylvania Electric Products launched an electron-tube promotion campaign at the consumer level, featuring a $2 rebate on the purchase of a Sylvania receiving tube in combination with a Silver Screen 85 picture tube. D. W.

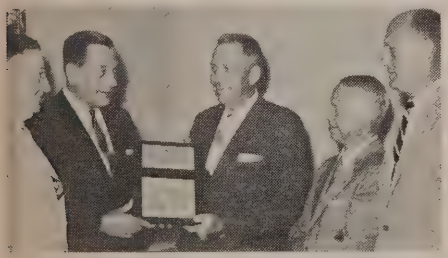
Gunn (left), vice president, sales, of Sylvania Electronic Tubes, and Warren L. Smith, president of Warren Radio Co., Toledo, Ohio, are shown manipulating puppets used to kick off the campaign.

Astatic Corp., Conneaut, Ohio, is merchandising its plug-in phono cartridges with a new colorful pilfer-proof



A-shape counter display. It holds 12 cartridges, each packed in a sturdy transparent plastic box.

CBS Electronics, Danvers, Mass., received an award from NATESA for outstanding service in creating better customer relations. A. L. Chapman,



CBS Electronics president (second from left), is shown receiving the award from Vincent Lutz, NATESA president. A. C. W. Saunders (left), educational director of NATESA, R. V. Bontecou, CBS Electronics vice president of marketing, and J. H. Hauser, distributor sales manager for the company (right), look on.

Westinghouse Electronic Tube Div., Elmira, N.Y., is offering over $50,000 in prizes in four Giant Jackpot contests

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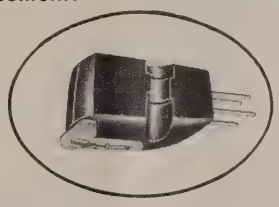
You make more profits on Stereo pickups with PICKERING'S NEW Program!

Think of it!...you can make 100% or more in profit on Stereo conversions and installation of Stereo pickups for replacement!



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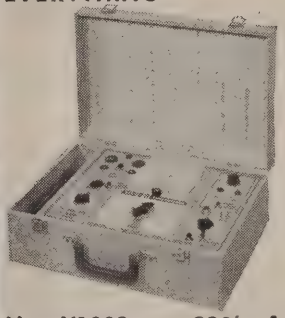

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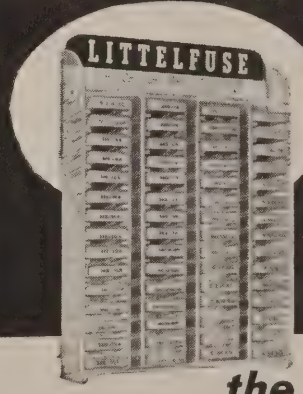

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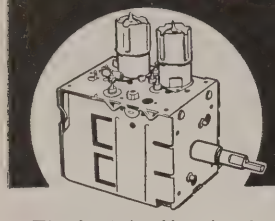

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*Subject to change

Tarzian-made tuners are easily identified by this stamping on the unit. When inquiring about replacements for other than Tarzian-made tuners, always give tube complement . . . shaft length . . . filament voltage . . . series or shunt heater . . . IF frequency and chassis identification. Use this address for fast, 48-hour service:

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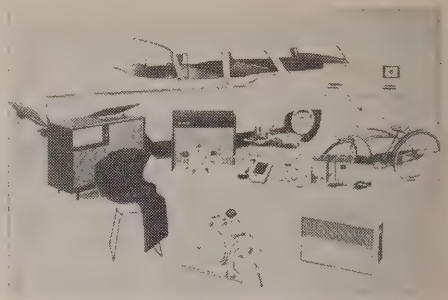

for TV–radio dealers and service technicians. A large collection of merchandise, including a Ford station wagon and various appliances, will be awarded.

Sherwood Electronic Laboratories, Chicago, manufacturer of hi-fi tuners, amplifiers and home music centers, presented its top sales award to Don Bacher

of Belchamber & French Co., San Francisco, for the greatest percent increase in sales over the previous year. Edward S. Miller, Sherwood general manager (left), is shown making the award.

Arco Electronics, Inc., New York, is now packaging its Elmenco DP dipped Mylar paper capacitors in moisture-proof transparent 5-Pak bags.

Dr. Herbert Trotter, Jr. (top left), was elected a senior vice president engineering of Sylvania Electric Products. He had been executive vice president of the Sharples Co. **James H. Brewster III** (top right), was appointed vice president, marketing, of Sylvania Electronic Systems. **Samuel A. Ferguson** (lower left), was named vice president and general manager, Mountain View, (Calif.) operations, and **Dr. Edwin G. Schneider** (lower right), vice president, research and engineering. Brewster was formerly director of customer relations; Ferguson, manager of

Mountain View operations, and Dr. Schneider, chief engineer of Sylvania Electronic Systems. Both Brewster and Dr. Schneider will have their offices in Waltham, Mass.

ORRadio Industries, Opelika, Ala., has designed a new Two-Way Profit Pack for TV and radio service technicians. It includes an assortment of

12 reels of Irish tape, a tape-recorder service manual and an identifying banner. The manual was prepared in cooperation with Howard W. Sams & Co., Inc.

Harold F. Bersche, manager, merchandising, Distributor Products Dept., RCA Electron Tube Div., Harrison, N.J., was promoted to manager, Distributor Products Dept.

James R. Bostwick joined Heath Co., Benton Harbor, Mich., as assistant to the vice president. He comes to the company from Temco Aircraft Corp., where he was a staff engineer.

David Hughes, a sales engineer in the Chicago territory for Hickok Electrical Instrument Co., Cleveland, was named director of marketing.

Frank M. Hickey was appointed merchandising manager for industrial products sales for CBS Electronics, Danvers, Mass. **George W. Tallaksen, Jr.,** formerly with G-E, succeeds him as Northeast regional sales manager.

Larry Hermann is the new assistant merchandising manager for Electro-Voice, Inc., Buchanan, Mich. He will remain as product manager, Wolverine Div.

Robert M. Andrews, advertising and sales promotion manager of electronic products for Tung-Sol Electric, Inc., Newark, N.J., was named electronics planning manager for distributor sales. **T. D. Stephens** was named manager of distributor sales in the Atlanta sales office.

END

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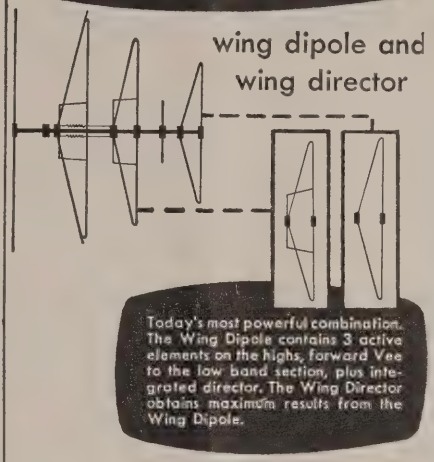
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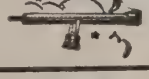

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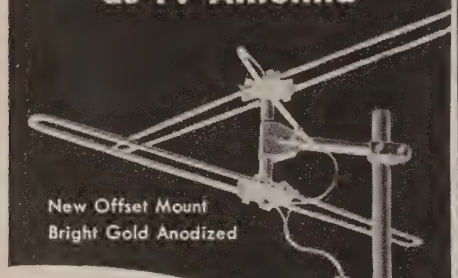

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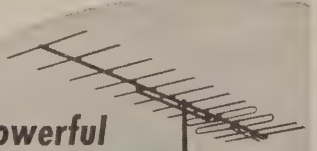

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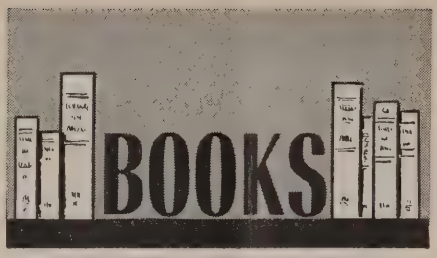

AUTO RADIO SERVICE DATA MANUAL, VOL 7. Howard W. Sams & Co., Inc., Indianapolis 5, Indiana. 8½ x 11 in., 240 pp. $3.75.

No. 7 in the continuing series covers 1956 and 1957 model car radios. Those familiar with Sams' treatment know that each set is shown in two or three photographs, and that parts list, alignment instructions and schematic diagrams are given.—*CG*

INFRA-RED LIGHT AND ITS USES (Project No. 9040, Popular Optics Library). Edmund Scientific Co., 101 E. Gloucester Pike, Barrington, N. J. 8½ x 10¾ in. 15 pp. 75¢.

Details such electronic–optical construction projects as infra-red telescopes, microscopes and telescope adapters, fire and intruder alarms and detection systems. Emphasis is placed on the optical systems, with lenses and mounting distances specified. Infra-red converter tubes and lenses are available from publisher at nominal rates.—*RFS*

OFFICIAL REGISTRY OF TRANSPORTATION RADIO SYSTEMS. Edited by Ethel V. Sleeper. Communication Engineering Book Co. Monterey, Mass. 8½ x 11 in. 69 pp. $4.

A callbook listing frequencies and addresses of stations operated by taxi, railroad, auto emergency, motor carrier and highway trucking companies. In Part 1, companies are listed alphabetically by state and city. In Part 2, the listing is by frequency with call signs, location and type of operation given.

CONDUCTANCE DESIGN OF ACTIVE CIRCUITS, by Keats A. Pullen, Jr. John F. Rider, Publisher, Inc., 116 W. 14 St., New York 11, N.Y. 6 x 9 in. 330 pp. $9.95.

The author shows how to design tube and transistor circuits for maximum efficiency and minimum distortion. His method is based on the use of special G (conductance) curves which indicate conductance values on the plate characteristic curves. A knowledge of Ohm's law and elementary math is needed.

The method of design in straightforward and the necessary formulas are given. The first chapters discuss principles and calculations pertaining to simpler circuits. Amplifiers, oscillators and detectors are covered later. Among the design factors studied are dissipation, bypass capacitance, load, stability, gain and distortion.—*IQ*

SOLID STATE MAGNETIC AND DIELECTRIC DEVICES, edited by H. W. Katz. John Wiley & Sons, 440 Fourth Ave., New York, N. Y. 6 x 9 in. 542 pp. $13.50.

Most books on solid-state electronics deal with transistors only. This one covers everything but transistors. Some of the topics studied are: piezoelectricity, superconductivity, parametric devices, electromechanics, ferroelectricity, magnetostriction. Theory and applications are discussed. Ferrite materials are given considerable attention. The book is recommended for readers who are well equipped with higher math.—*IQ*

1959 SOLID-STATE CIRCUITS CONFERENCE (Philadelphia), Digest of Technical Papers, edited by Robert F. Cotellessa. Publisher, Lewis Winner. 8½ x 11 in. Paper. Available from Henry G. Sparks, Moore School of Electrical Engineering, University of Pennsylvania, 200 So. 33 St., Philadelphia 4, Pa. $4.

The conference, attended by nearly 2,000 leading workers in the solid-state field, gave birth to 40 papers, which appear in full or in abbreviated form in this digest. Subjects covered included reactance amplifiers, memory techniques, Hall-effect devices, cryotrons, masers, twistors, photo- and avalanche transistors and more conventional solid-state applications such as switching circuits and rectifiers. A compendium of the latest in the solid-state field. —*FS*

FUNDAMENTALS OF RADIO AND ELECTRONICS (2nd Edition), edited by W. L. Everitt. Prentice-Hall Inc., 70 Fifth Ave., New York 11, N.Y. 6 x 9¼ in. 805 pp. $11.

Completely rewritten and updated, this book is especially valuable to radio operators, radio and electronic technicians, and engineers. It provides a thorough review of mathematics and electrical engineering. Some of the topics covered by the text are mathematics of radio and electronics, direct-current circuits, electromagnetic waves, frequency modulation, color television, radio-wave propagation, industrial applications, and an appendix of safety and special radio services.—*LS*

BASIC RADIO AND RADIO-RECEIVER SERVICING (2nd Edition), by Paul B. Zbar and Sid Schildkraut. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y. 8¼ x 11 in., 130 pp. $2.25.

So you want to be a service technician? The first step is learn electronics theory and practice as taught by a good school. A thorough text will help. This one is part of a series of EIA laboratory manuals. It is intended primarily for training radio technicians. This volume starts with job 51 and continues through job 75. All are laboratory type experiments which should be combined with classroom instruction to give the student a true picture of the servicing business.—*LS*

TRANSISTORS by Angelo C. Gillie. Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 in. 262 pp. $7.95.

This one is for beginners. It starts with linear and nonlinear conductors, follows with diodes, then proceeds to transistors. This order gets the student off to a good start. The book stresses theory, and the many schematics do not list typical or practical component values. All explanations are physical, and math is avoided. The author uses

simple equivalent networks to analyze transistor circuits.

Each chapter includes worked-out examples and ends with questions and problems. Answers appear at the end of the book. One chapter is on point-contact transistors. The final chapter discusses rectifiers, thermistors, surface barriers and related devices. The text is clearly written and is aided by many graphs and diagrams.—*IQ*

FM RADIO SERVICING HANDBOOK, by Gordon J. King. MacMillan Co., 60 Fifth Ave., New York 11, N.Y. 9 x 6 in. 192 pp. $5.

A theoretical and practical guide to FM radio including design, construction, alignment and repair. Unfortunately for the US technician the book is written with a British slant, and the circuits and receivers used as examples are unfamiliar to the American reader.

LAYMAN'S GUIDE TO HI-FI, by Byron Wels. American Electronics Co., 1203 Bryant Ave., New York 59, N.Y. 6 x 9 in. 76 pp. $1.25.

This helpful little book for beginners contains a wealth of information carefully assembled and clearly written and is relatively well illustrated. There are numerous minor errors which an expert would not have committed, and the book was apparently written in 1958, since stereo is almost entirely avoided.—*CG*

ELECTRONIC COMMUNICATION, by Robert Shrader. McGraw-Hill Book Co. Inc., 330 W. 42 St., New York 36, N.Y. 6 x 9¼ in. 937 pp. $13.

A comprehensive text that contains everything the reader needs to know about electricity, electronics and radio to pass FCC amateur or commercial license examinations. Despite this, the book is not a license manual. It is a text that goes into all phases of communications. Among its topics are current, voltage and resistance; alternating-current circuits; basic transmitters; transistors; motors and generators; radio direction finders; radar; basic communications law; amateur rules and regulations.—*LS* END

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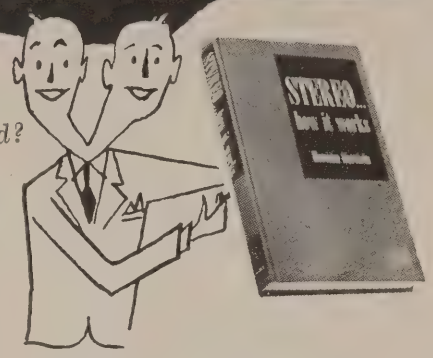

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TV AND AUTO RADIO CONTROLS. *Replacement Guide RGC-2* lists hundreds of volume, tone and other controls for 22,000 models of TV sets and auto radios. Includes an index, IRC Concentrikit and Mallory Sta-Loc equivalents.—**Howard W. Sams Co.,** 2205 E. 46 St., Indianapolis 6, Ind. **$1.**

DIPOLES AND YAGIS, a reprint from RADIO-ELECTRONICS of an article explaining the effects of stacking antennas. Polar diagrams are shown in this 4-page brochure—**Scala Radio Co.,** 2814 19 St., San Fransisco 10, Calif.

RESISTORS AND CONTROLS are covered in *catalog No. 59.* Also included are tab-mount controls and miniature series 57 precision pots.—**Clarostat Mfg. Co.,** Inc., Dover, N.H. Also available at Clarostat distributors.

AUTO RADIO SWITCHES for 60 models are shown in the supplement *Auto Radio On–Off Switch Cross-Reference.* These are for pushbutton sets in 10 makes of cars from the '40's to present. —**Centralab** Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee, Wis.

TUBE-TRANSISTOR HANDBOOK includes receiving, special-purpose and picture tubes. Complete EIA engineering design data are given in the 700 pages of this second volume.—**CBS-Hytron,** Danvers, Mass. Both volumes, **$10.** Supplement service, $3 for 2 years.

PROFESSIONAL MICROPHONES, *catalog 120A,* a 24-page book giving full information and list prices on 8 microphones and accessories for broadcast and other high-quality applications.—**Electro-Voice, Inc.,** Buchanan, Mich.

MICROWAVE TUBES can be chosen from this selection chart listing magnetrons, traveling-wave tubes, klystrons and others. Frequency range, power, noise figure and operating conditions are shown.—**G-E Power Tube Dept.,** Schenectady 5, N. Y.

PA SPEAKERS, microphone stands and accessories are described in *catalog 59A.* This 6-page bulletin concentrates on horn projectors, paging speakers and other units used in commercial PA work.—**Atlas Sound Corp.,** 1449 39 St., Brooklyn 18, N. Y.

TUBE AND TRANSISTOR MANUAL, 11th edition, contains technical data on 1,000 receiving tubes, 250 special-purpose tubes, 265 picture tubes, 240 diodes and transistors. Includes supplements mailed every 3 months. — **Sylvania Electric Products, Inc.,** 1740 Broadway, New York 19, N. Y. **$3.** Available from Sylvania distributors.

ECHORASER is explained in detail in a little 12-page booklet. The unit reduces print-through on recorded tapes.—**Audio Devices, Inc.,** 444 Madison Ave., New York 22, N. Y.

PANEL INSTRUMENTS *catalog 59-1* is an 8-page listing of panel meters including the new 4-inch Unimeters. These are two-piece instruments which have independent scales and movements, arranged for instant matching.—**Triplett Electrical Instrument Co.,** Bluffton, Ohio.

INFRA-RED AND OPTICAL GEAR is shown in *catalog 594.* Complete infrared sniperscopes and parts are cataloged. 96 pages, primarily listing telescopes, optical lenses, prisms.—**Edmund Scientific Co.,** Barrington, N. J.

AUDIO ACCESSORIES *catalog AD-59* lists 16 pages of handy items used in tape recording, phonograph playing and complete systems. Many of these have previously been available from other makers. Gathered here in one listing they include testing devices and maintenance supplies as well as cables, plugs and adapters.—**Audiotex Mfg. Co.,** Div. of G-C Textron, Inc., 3225 Exposition Place, Los Angeles 18, Calif.

INERTIAL GUIDANCE is explained in layman's language in a 16-page booklet. Gyroscopes, computers and accelerometers are related and simply discussed in *What Is Inertial Guidance?*—**Sperry Gyroscope Co.,** Great Neck, N. Y.

RF SWEEP GENERATOR *catalog 8-A* describes sweep generators, markers, attenuators, filters and detectors for precise measurement of frequency response in the laboratory and on the production line.—**Telonic Industries,** Inc., Beech Grove, Ind.

CLIPS, ADAPTER, PLUGS, JACKS and numerous other useful small service parts are listed, pictured, and shown in mechanical drawings on 40 pages of *Catalog No. 59.*—**Herman Smith Co.** Available at dealers.

PRECISION INSTRUMENTS for laboratory use are shown and described in detail in *Catalog 558.* Bridges, Q-meters, null detectors and megohmmeters are among the over 20 types listed.—**Freed Transformer Co.,** 1718 Weirfield St., Brooklyn 27, N. Y. END

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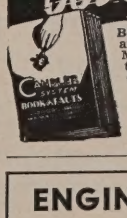

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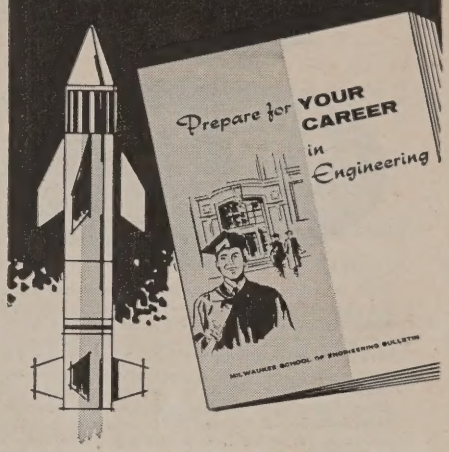

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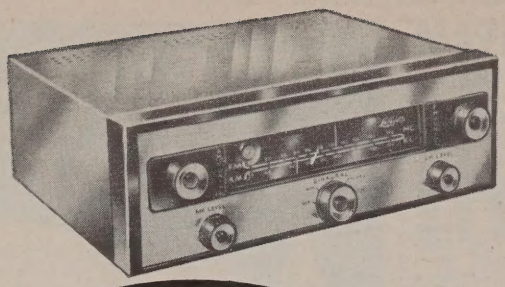

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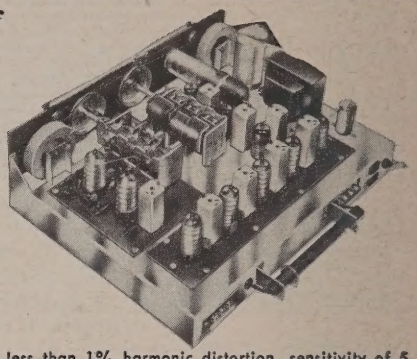
Use it as a Dual-Monaural FM-AM tuner
Use it as a straight Monaural FM or AM tuner



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FM specifications include grounded-grid triode low noise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvolt. AM specifications include 3 stages of AVC, 10 kc whistle filter, built-in ferrite loop antenna, less than 1% harmonic distortion, sensitivity of 5 microvolts, 8-kc bandwidth and frequency response 20-5000 cps ± 3 db.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

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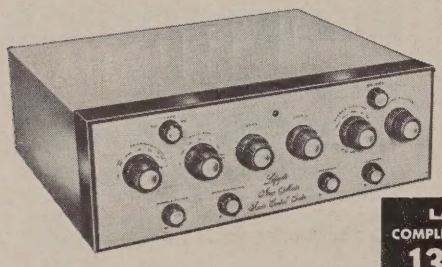

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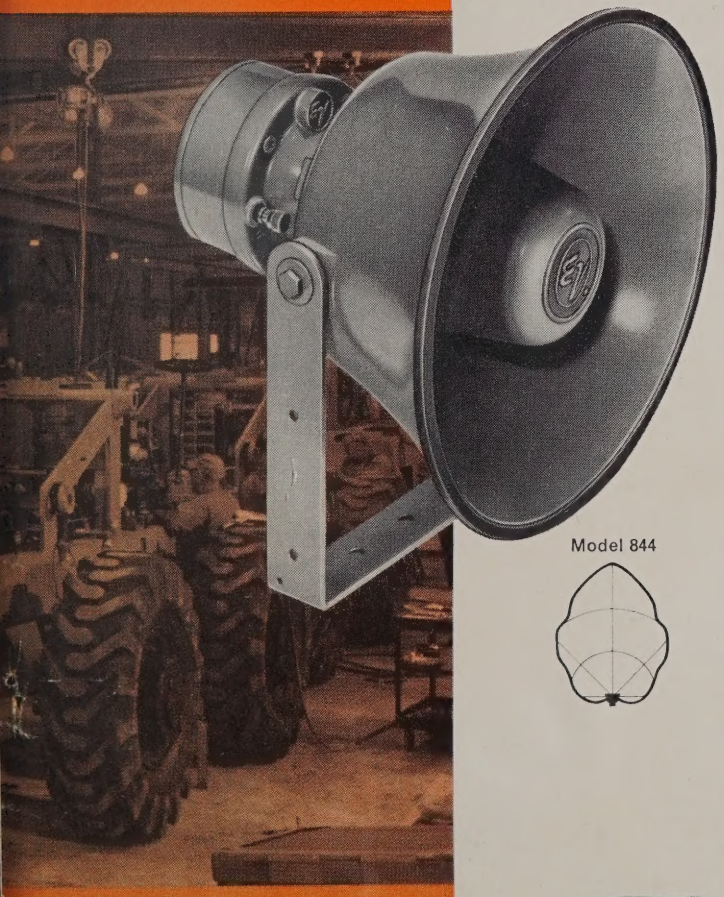
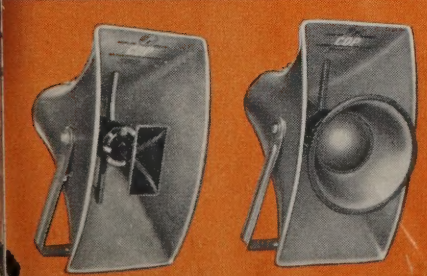
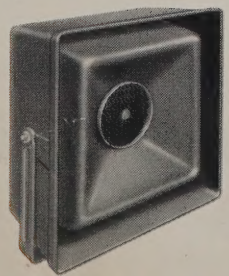


Model 844





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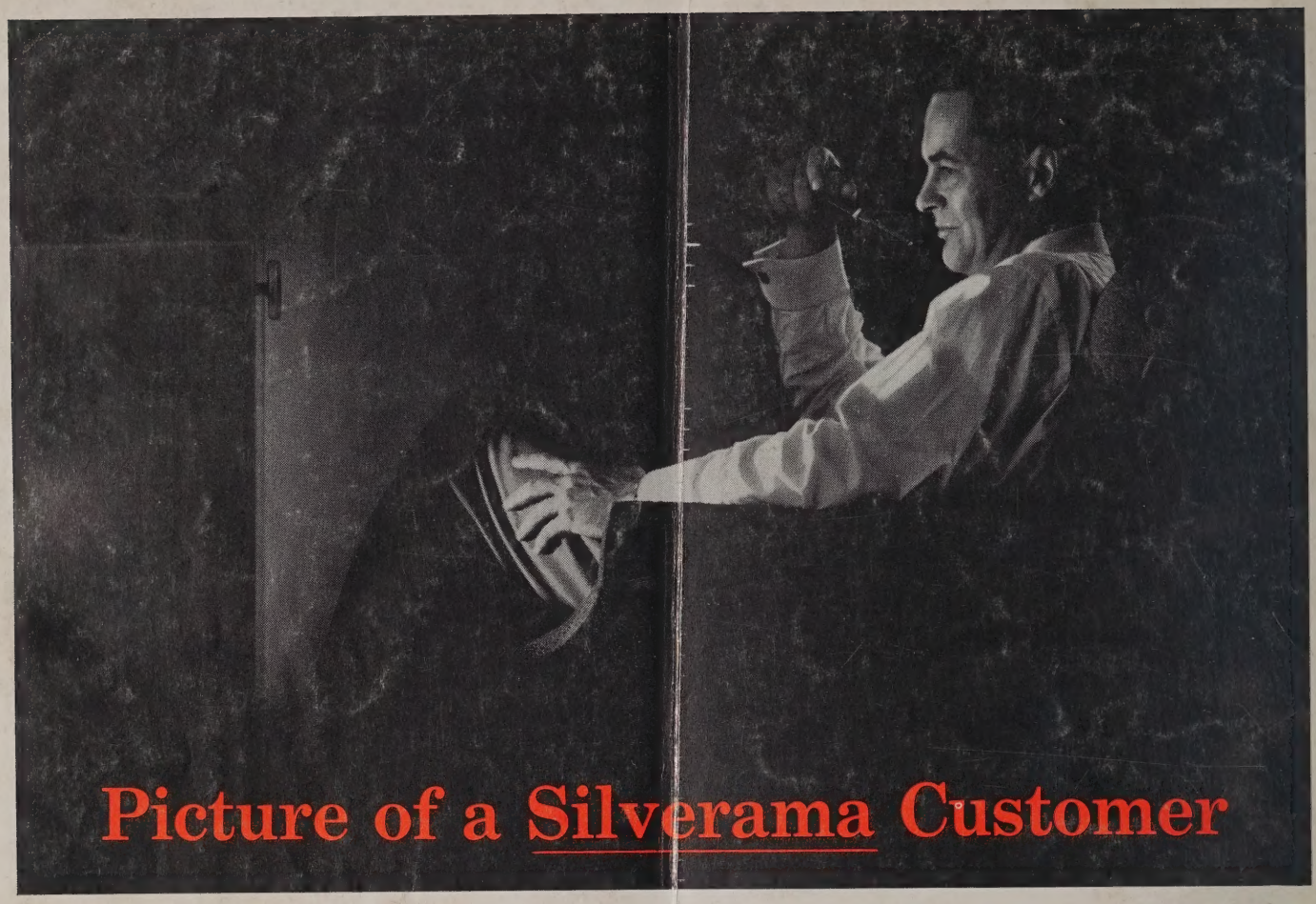

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